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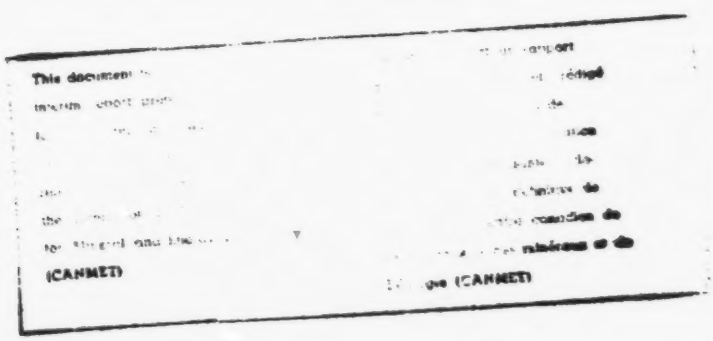
APPLICATION OF TRUCK DISPATCHING AT IRON MINES IN LABRADOR

V. Srajer

August, 1988



58pp

COAL RESEARCH LABORATORIES
DIVISION REPORT CRL 88-51 (TR)

MICROMEDIA

APPLICATION OF TRUCK DISPATCHING AT IRON MINES IN LABRADOR

by

V. Srajer*

ABSTRACT

Three open pit iron ore mines were visited during the period of June 18 to 23, 1988: Iron Ore Company's Carol Project in Labrador City, NFLD, Cleveland-Cliff's Scully mine in Wabush, NFLD., and Quebec Cartier Company's Mount Wright mine in Fermont, Quebec. The author was accompanied at this tour by representatives of Wenco International Company of Vancouver, B.C., CANMET's contractor for the Truck Management project. The purpose of the visit was to examine truck sensing and dispatching systems used at the visited mines, and compare these systems with proposed dispatching component of the Truck Management project.

Review of dispatching systems used or proposed to be used at these mines is presented in this trip report.

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APPLICATION DU SYSTÈME D'INFORMATION SUR LA RÉPARTITION DES CAMIONS DANS LES MINES DE FER DU LABRADOR

par

V. Srajer*

Nous avons visité trois mines de minerais de fer à ciel ouvert pendant la période du 18 au 23 juin 1988, dont le Projet Carol de la société Iron Ore à Labrador City, T.-N., la mine Scully de la Cleveland-Cliff à Wabush, T.-N., et la mine Mount Wright de la société Québec Cartier à Fermont (Québec). Des représentants de la Wenco International Company de Vancouver, C.-B., entrepreneur responsable du projet d'information sur la répartion des camions pour le compte de CANMET nous ont accompagnés pendant la visite. Nous avons ainsi eu l'occasion d'examiner les systèmes de détection et de répartition dont sont équipés les camions qui circulent dans la mine et de les comparer aux composantes du système de répartition que l'on projette de mettre en oeuvre dans le cadre projet d'information sur la répartition des camions.

Ce compte rendu de la visite que nous avons effectuée dans les trois mines comprend également une étude des systèmes d'information sur la répartition des camions qui sont déjà en service ou de ceux que l'on projette d'y installer.

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INTRODUCTION

Wenco International Mining Systems Ltd. of Vancouver, B.C. was awarded contract to Develop, Demonstrate and Evaluate an Integrated Truck/Shovel Operating and Management System in Producing Surface Coal and Oil Sands Mines. As part of the Phase 1 of the contract, existing truck/shovel dispatching systems are evaluated, system requirements are defined to fit into overall conceptual design, and subcontractors for the projects are selected.

The iron mines in Labrador were visited to evaluate their existing mine dispatch systems, solicit evaluation and criticism of mine operators on their dispatch system, and compare features offered by suppliers of different dispatch systems.

The Iron Ore Company's Carol Project, open pit mine in Labrador City, NFLD., is using Modular Mining Dispatch System. The system has been operational for the last five years and the original cost was around $ 1.2 Million. The Cleveland-Cliff Wabush mine in Wabush, NFLD. is accepting Production Monitor and Control System (PMCS) developed by Wenco International on a trial basis, commencing in the summer of 1988. A total system, when installed after completion of the trial period, is expected to cost up to $ 0.5 Million. Quebec Cartier's Mount Wright pit in Fermont, Quebec, is using a system developed by Ecole Polytechnique of Montreal, Quebec. This system replaced original Control Data system installed approximately ten years agou. Most of the development, additions and improvement of the system, were done in-house, using outside consultants. A conservative estimate of the system is around $ 1.35 Million. At the present time, the existing system is being re-evaluated and is expected to be replaced by the updated version from Ecole Polytechnique, or by some other commercially available system. Wenco International presented a proposal to the mine consultant for replacement of the existing system with PMCS system at a cost of up to $ 0.6 Million.

Existing dispatch systems used at the visited mines are described in this report, using information available from the mine engineering staff or provided by system suppliers.

DESCRIPTION OF THE MINES

The Iron Ore Company's Carol Project open pit mine is located approximately 7 km north of the centre of the town of Labrador City. The Carol Project goes back to 1947 when the Iron Ore Company of Canada decided to activate mine development in the Labrador area. The mine property consists of three pits: Humphrey, Lorraine and Smallwood. The combined ore reserves of the region are up to 1.2 Billion tonnes.

The ore occurs as magnetite and specular hematite with an average grade of 37 % iron. The ratio of hematite to magnetite is 7:3. All the ore bodies occupy synclines and are overlay by waste rock (quartz-grunerite, quartz-carbonate and quartzite). The generalized mine plan is shown in Figure 1, typical section of the ore bodies is in Figure 2.

The mine planning department produces five year long term plan and three types of short term plan:

- one year plan, completed every September for the following year, specifying tonnage production, waste volume, grades and drill sequencing requirements,
- monthly plan, completed at the end of each month for the following month, specifying production in detail and also show shovel production schedules,
- week plans, which detail the shift-by-shift shovel production schedule, including daily grades and shovel production in iron and waste, blasting and shovel maintenance schedules.

All blast holes are designed on a square pattern with the spacing controlled by the rock type and the hole diameter. The hole depth is 15.2 m

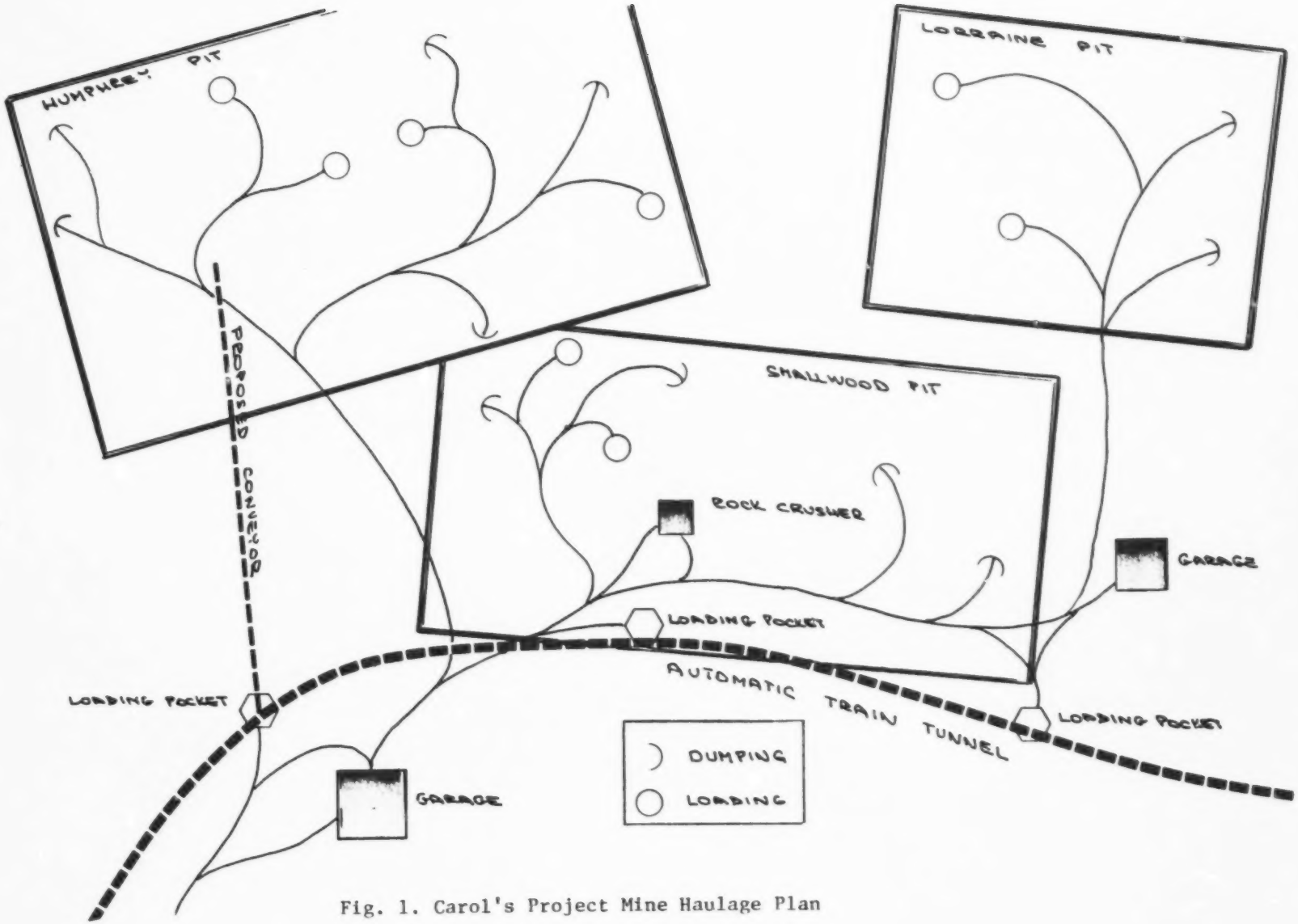

Fig. 1. Carol's Project Mine Haulage Plan

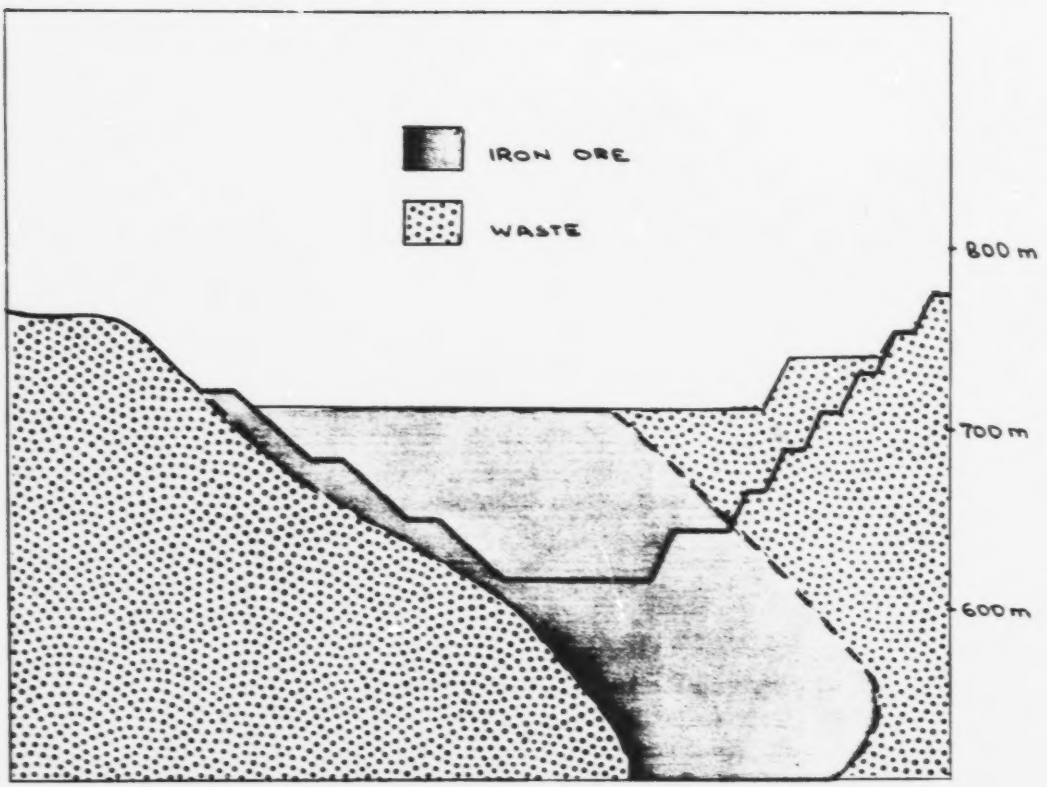

Fig. 2. Typical Section of the Ore Body

of which 13.7 m is bench height and 1.5 m is subgrade. For a typical blast about 150 to 200 holes are drilled. Two PROCORE primers are used per hole, each being suspended on separate SCUF-FLEX downlines. The bottom 2.45 m of each hole is filled with HYDROMEX M-210, with the next 6.0 m being filled with HYDROMEX T-3. The remainder of the hole is then filled with the crushed rock. Prior to blasting all holes are connected by PRIMACORD and 25 and 40 millisecond delays to two electric blasting caps. Boulders too large for handling, resulting from the primary blasts are blasted independently. Mobile Roc-Jac drills are used to drill 5.1 cm diameter holes into each boulder in which are inserted lengths of catridges. Approximately one percent of the total production material need to be secondary blasted. In Smallwood pit, preshearing for final wall control was practiced. Specifications are as follows: spacing - 3.05 m, subgrade - 0.61 m, explosive - loaded with POWERMEX 300 to 3.96 m collars, and primed at two locations 1.52 m and 7.62 m from bottom on standard 13.7 m bench, hole size - 25.1 cm diameter with explosive loaded into 10.16 cm diameter tubing.

The ore crusher, concentrator and pellet plant are located approximately 11 km from the mine loading pockets. Due to the fact that the pits are not adapted for the direct train loading type of mining, a system of tunnels and loading pockets are used. The loading pockets are surge bins blasted out of solid rocks. There are three loading pockets used at the mine, with pan-feeders at the bottom, which transfer ore to the ATO ore cars. The total storage capacity of the pockets is 85,000 tonnes. The ATO system consists of seven 20-car trains which operate a double track. An empty train will travel from the crusher over the western track to the loading pockets. After loading, the train runs on the eastern track to the crusher. Each car carries 100 tonnes and a loading time of 20 minutes is required per 20-car train. The crushers are Allis-Chalmers 1524 mm x 2261 mm gyratory cones with an estimated annual capacity of 45 Mt.

A fleet of 52 electric wheel trucks of 122 t to 152 t capacity (Wabco, Terex, Titan, Euclid) is used for ore and waste transport. The fleet

of shovels currently employed consists of 6 Komatsu-Bucyrus 280's, 1 B-E 280, 1 Marion 191, and 4 P&H-2300. Capacities range from 10.7 m^3 to 16.0 m^3. The typical haulage road is 34 m wide, maximum allowable slope is 8 %.

Two shops are used for mobile equipment maintenance, including loaders, crawlers, trucks and graders, one separate facility is used for shovel and drill maintenance and overhaul. There are two steam bays used for cleaning of equipment, and one tire shop. Table 1 lists all mine site equipment, Figures 3 to 6 illustrates mine operation.

Recent decision to develop Humphrey South pit will mean that a long haul distance of 3 km will be required, increasing operating cost dramatically. The company is therefore studying proposal to introduce an in-pit crusher and conveyor system, using 4160 kV power supply. The system will employ a movable 1524 mm x 2261 mm gyratory crusher within the pit boundary, being supplied with material by trucks on short, level haul. The crushed ore is then conveyed by a short belt conveyor onto a steep angle conveyor at the edge of the pit from which the belt conveyors will transport the product to the existing ATO system at No. 2 loading pocket. The conveyor is proposed to be 2.9 km long. A stockpille capacity of 400,000 tonnes of material will be available at pocket.

Other project being examined include the feasibility of conveying waste rock to dump areas, methods to improve energy conservation in the concentrator, and use of micro-processors in the pellet plant and concentrator.

The Cleveland-Cliff Wabush Mine is located approximately 17 km southeast from Labrador City and about 3 km from the town of Wabush. The mine is managed by Pickands & Mather Company. Only one mining area, Scully mine, is operational at present. The mine area is divided into East, West, South, and West Extension pits.

Table 1. IOC Mine Equipment List

MINING EQUIPMENT LIST

DRILLS

TYPE	QUANTITY
Bucyrus Erie 50R Rotary Drill	3
Bucyrus Erie 60R Rotary Drill	9
Gardner Denver 120 Rotary Drill	3
Diamond Drills	2
Roc-Jacs (Air Trac) Security Drills	4
Gardner Denver 600 CFM Compressor	1

SHOVELS

TYPE	QUANTITY
Komatsu-Bucyrus 280 Shovel	6
Bucyrus Erie 280 Shovel	1
Marion 191 Shovel	1
P & H Shovel	4
Bucyrus Erie Backhoe	1

TRACTORS

TYPE	QUANTITY
CAT 930 Loaders	3
CAT 988 Loaders	2
CAT 992 Loaders	1
CAT 824 Rubber-Tire	2
CAT 834 Rubber-Tire	2
CAT 988-B Rubber-Tire	4
CAT D-9H	3
CAT D-9L	3
CAT 16-G Grader	6

TRUCKS

TYPE	QUANTITY
Wabco 120-T Haulage Trucks	23
Terex 150-T Haulage Trucks	23
Titan 150-T Haulage Trucks	5
Euclid R-170 Haulage Trucks	1

AUXILIARY EQUIPMENT

TYPE	QUANTITY
Heavy Equipment Tow Truck ('Skunk')	1
Cable Truck	1
Fuel Truck	1
Floats	2
Water Trucks for mine dust control	3
Calcium Trucks for road maintenance	3
Service Trucks for general purposes	4
Boom Truck	1
P & H Crane	2

EXPLOSIVES TRUCKS

TYPE	QUANTITY
GELMASTER Slurry Trucks	3
AN/FO Trucks	2
EDT Service Trucks	2

TRANSPORTATION

TYPE		QUANTITY
1/2 ton Trucks	Operations	23
	Maintenance	27

AUTOMATIC TRAIN DATA

Locomotives

Manufacturers	- C.N. Diesel (Canada)
Gross Weight	- 1 135 000 kg
Motor Generator	- 2300 Volt
Traction Motors	- 4 x wound D.C. 298 hv (400 H.P.) in series - parallel
Pantographs	- Steinmann
Power	- 1982 hv (1450 H.P.), 18 160 kg (40 000 lb.) tractive effort
Wheel Size	- 1 016 mm (40 in.)
Catenary	- by British Insulated, Callender Constructive Ltd., U.K. Total tension 2 043 kg (4500 lb.)

Ore Cars

Wheel Size	- 965 mm (38 in.)
Capacity	- 102 tonnes (100 LT)
Unit Weight	- 49 tonnes (48 LT)

Track

- a. 60 kg rail (132 lb.) maximum curves 5 degree
- b. ribbon rail with ends field thermo-welded
- c. life of rail is two years on south-bound curves (loaded)

Length of Run - 11.26 km

System Capacity

Daily with 20-car trains - 309 317 t/day or 304 000 LT/day

Annual Crude Ore Handled - 41 000 000 long tons, equivalent to 90% of capacity, 41 600 100 metric tonnes. (Eg 1981)

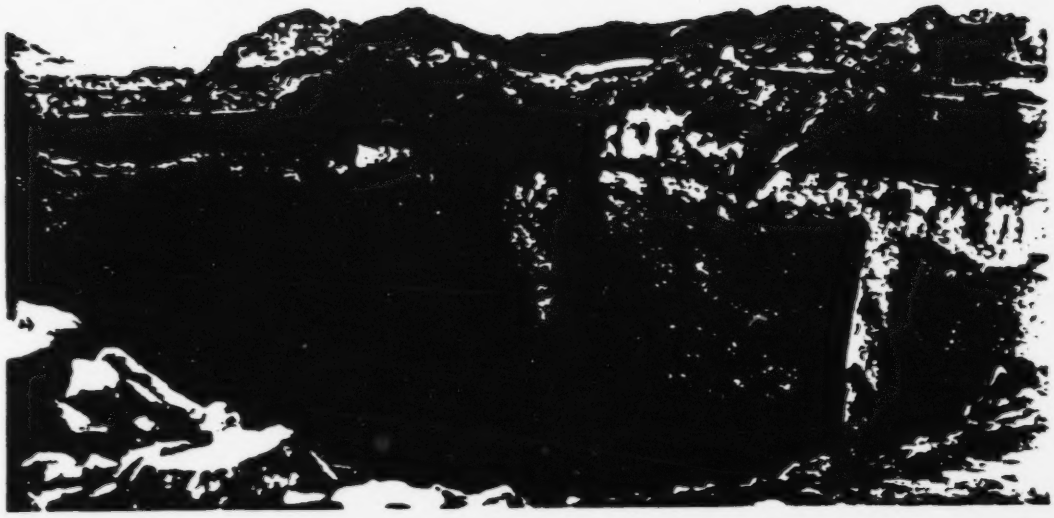

Fig. 3. Humphrey's Pit Dump Pocket

Fig. 4. Humphrey Pit: Loading at No. 20 Bench

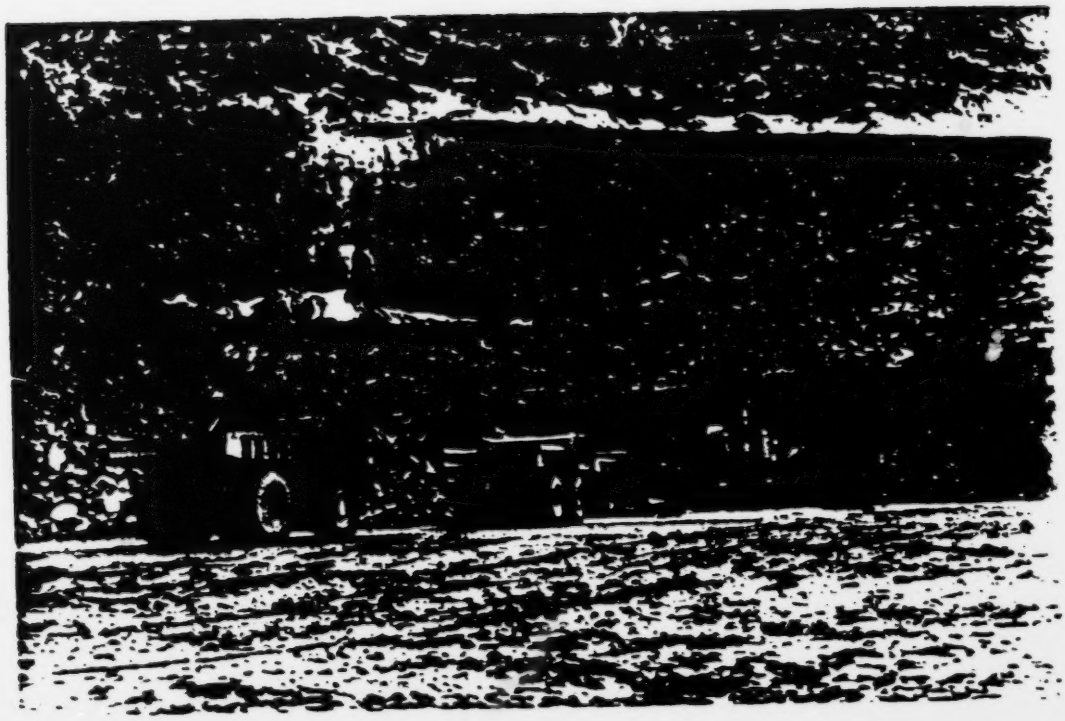

Fig. 5. Trucks Queuing at Lorraine Pit

Fig. 6. View of the Smallwood Pit

A total of eight shovels are employed at the mine, loading into 14 Euclid R-170 trucks. One Euclid R-100 truck is presently used for utility work. Four drills are used continuously to drill ore and waste material. During the mine visit, only five shovels were operating, four in ore, one in waste. According to the mine engineer, this is quite typical assignment. The mine haulage was well designed, having very smooth and firm surface. According to the mine manager, well designed mine haulage roads increased life of the tires to 7,600 operating hours. Longest haul is at present from West Pit Extension, averaging 20 to 27 minutes/cycle. The ore is dumped into two dump pockets, crushed and loaded to the trains.

The mine produces 16,500 tonnes of concentrate per day. Mine plans of production requirements are done on monthly basis. The ore is carefully blended, production is scheduled from each pit to assure proper blend. The following feed composite is considered optimum:

- iron content: 28 - 40 %, optimum 36 %,
- manganese content: 0.2 - 5.0 %, optimum 1.0 %,

The results from three holes is used to calculate the composite, forming block of ore approximately 10,000 tonnes. Mine plan for the month of June 1988 called for the following ore blend and quantities to be mined from each pit (period May 29 to July 9):

PIT	%	TONNES
East	21	450,000
West	26	500,000
South	18	385,000
Extension	35	725,000

During the same period, each shovel was assigned the following quantities of ore and waste to be loaded:

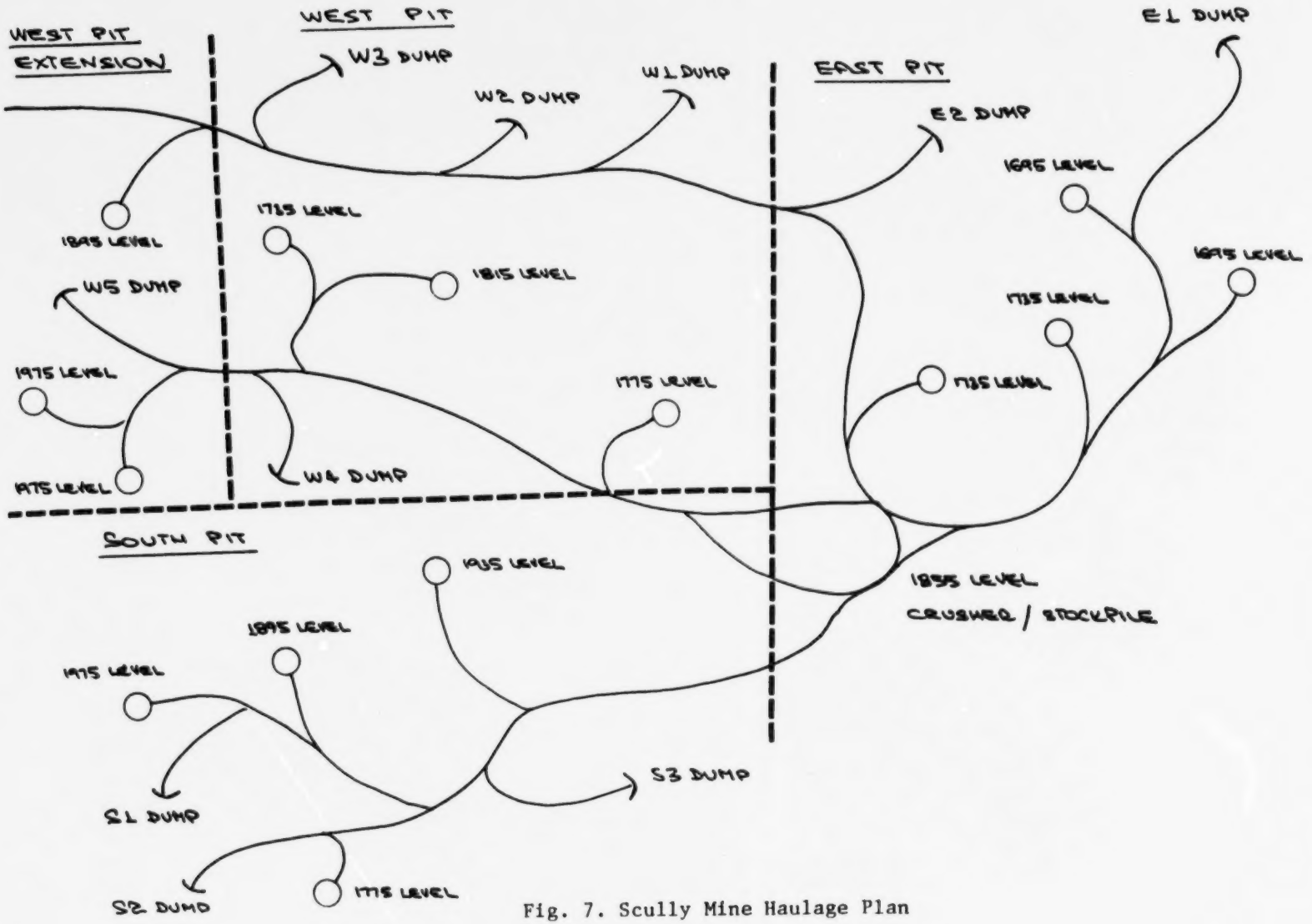

Fig. 7. Scully Mine Haulage Plan

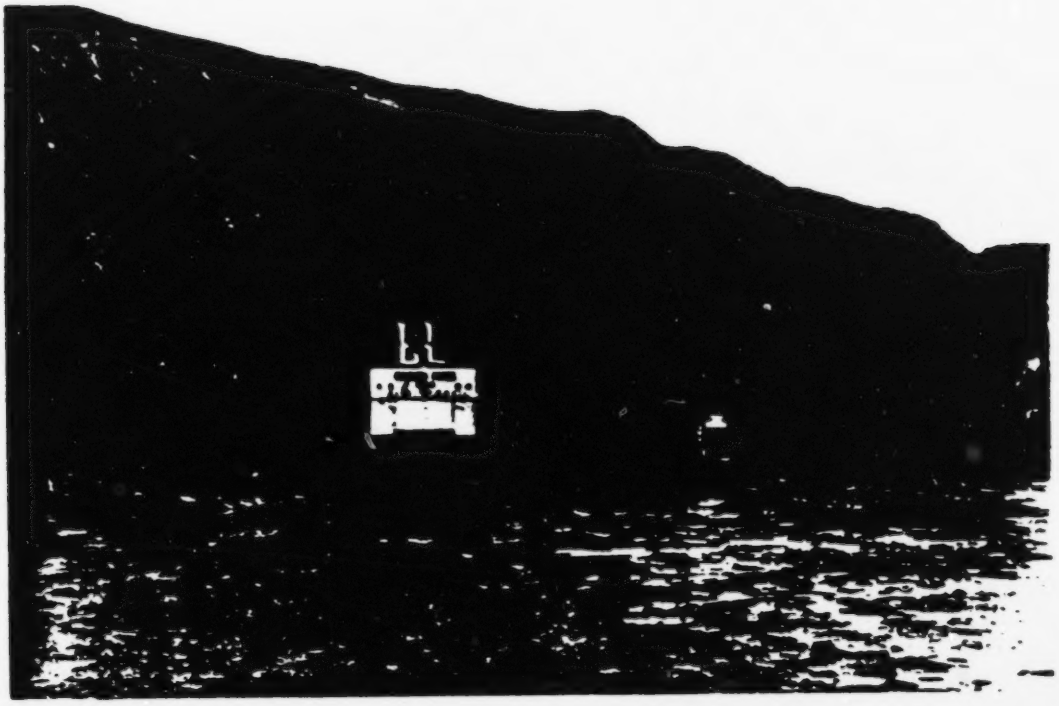

Fig. 8. Scully Mine West Pit Loading Operation

Fig. 10. View of Mount Wright Operation

PIT	LEVEL	Shovel #	Tons of Ore	Tons of Waste
South	1735	1	385,000	14,000
South	1775	2	200,000	Nil
East	1695	6	350,000	50,000
East	1735	7	100,000	200,000
West	1895	5	350,000	50,000
Extension	1975	3	350,000	80,000
Extension	1975	4	375,000	120,000

The shovel No.8 was not assigned to production during this period. Average ore to waste ratio in 1988 production plan was 4.1:1.

The mine plan is shown in Figure 7, view of the loading in West pit is in Figure 8.

The Quebec Cartier's Mt. Wright Mine is located approximately 40 km west from the Labrador City and about 12 km from the town of Fermont. The town of Fermont and the mine lies in the Province of Quebec and therefore in Eastern Time zone, having two hours time difference to mines, habitation and airport located on Newfoundland site.

The mine was opened in July 1975 with a capacity of 18.4 million long tons per year. The ore structure consists of two intersecting synclines, the westernmost of which trends northeast and is intersected at its eastern end by another sysncline trending northwest. The north limb of the west syncline dips steeply north while the south limb tends to flatten out. The waste rock is quartzite banded with fine grained muscovite mica schists and gneisses. The ore is fine grained specular hematite with about 10 % magnetite in the Mount Wright section of the deposit and negligible magnetite elsewhere. Ore grade averages 31.4 % iron with the mine designed to achieve proper blending by mining the Main and West orebodies at the same rate.

The mine haulage road is minimum 30 m wide with an average grade of 8 %, going to a maximum of 5 % in the curves. The average ore haulage cycle for the trucks is 23 minutes. The waste dumps are located at the edges of the pit areas.

The benches in the pit are 14 m high with a maximum width of 46 m. The ore drill pattern is 9.0 x 9.0 m, slightly less in waste (8.8 x 8.8 m), drilling 30 cm diameter holes. Five Gardner-Denver 120 drills and two Bucyrus-Erie 60R series drills are used at the mine. Pit slope control is done by pres-shearing with 30 cm holes at 3 m intervals, then half loading the holes. On the south side of the deposit the 40 degree footwall provides a stable slope.

The loading is done by five P&H-2100 BL 12.6 m^3 shovels, four BE-295 B 15.3 m^3 shovels and three Marion M-192 15.3 m^3 shovels. Haulage fleet consists of eight Unit Rig's Lectra Mark 36 136 tonnes, seventeen Terex 33-15 136 tonnes and eight Wabco 170-C 155 tonnes. During the mine visit six of the shovels and 25 trucks were operational. Additional three Letourneau L-700 10.3 m^3 rubber-tired front-end loaders and two Dart D-600 front-end loaders are used to clean up the face and low bank material. The loaders handle 11 % of all the material moved in the mine. Total of 31 million m^3 is moved at the mine in one year.

The crusher house at the concentrator contains two standard 183 x 3320 cm Allis-Chalmers gyratory crushers with a feed capacity of 5000 tonnes per hour each. Below each crusher are two pan feeders, each pair emptying onto a 2.0 m wide steel cord conveyor belt. The processed concentrate is conveyed to a single silo with a capacity of 27,300 tonnes loading directly into railway cars. A 155-car train with 82 tonnes capacity cars is loaded in one hour. There are four such trains each day to be loaded.

The mine plan is shown in Figure 9, Figures 10 to 12 illustrate various operations in the mine.

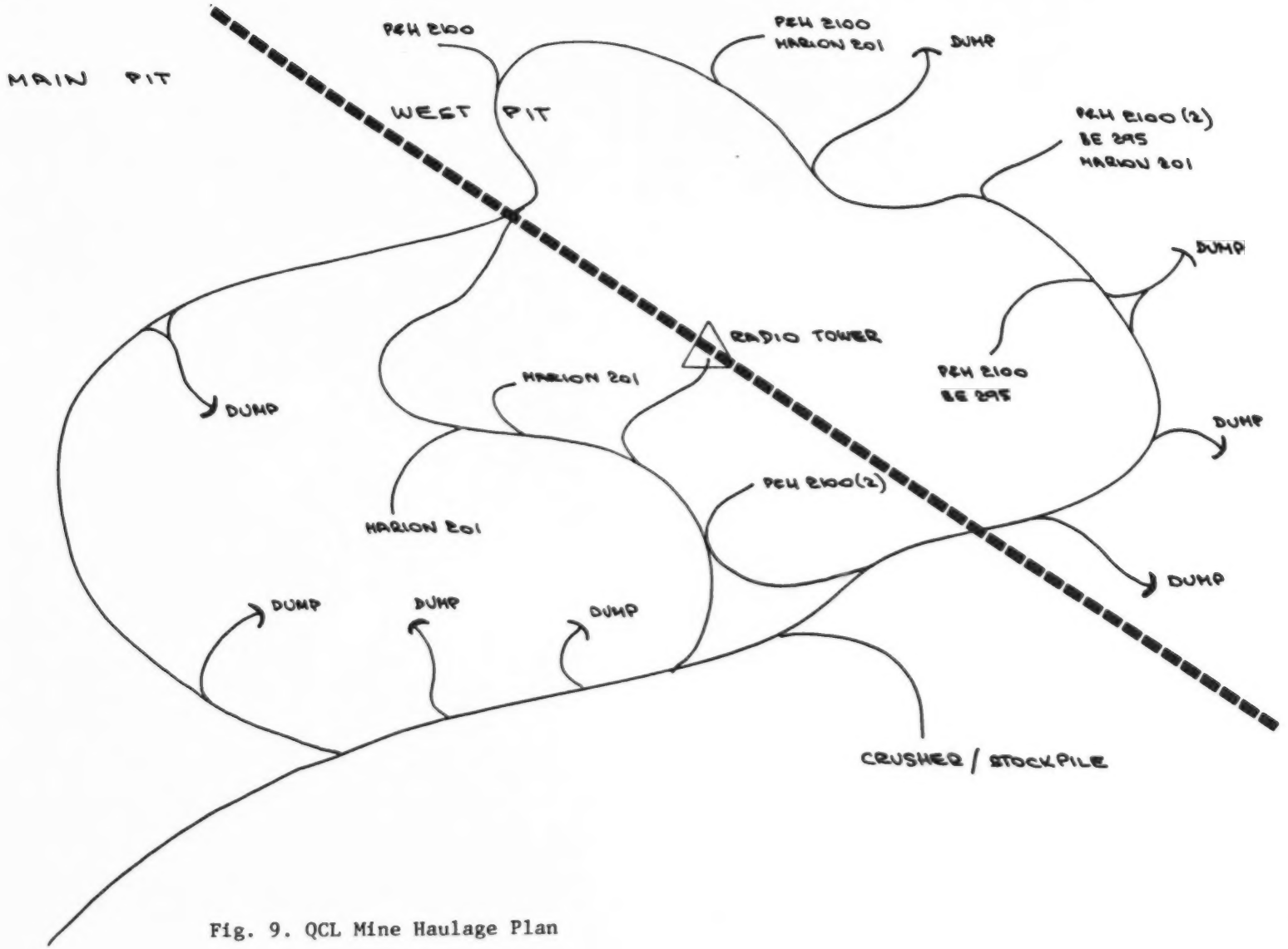

Fig. 9. QCL Mine Haulage Plan

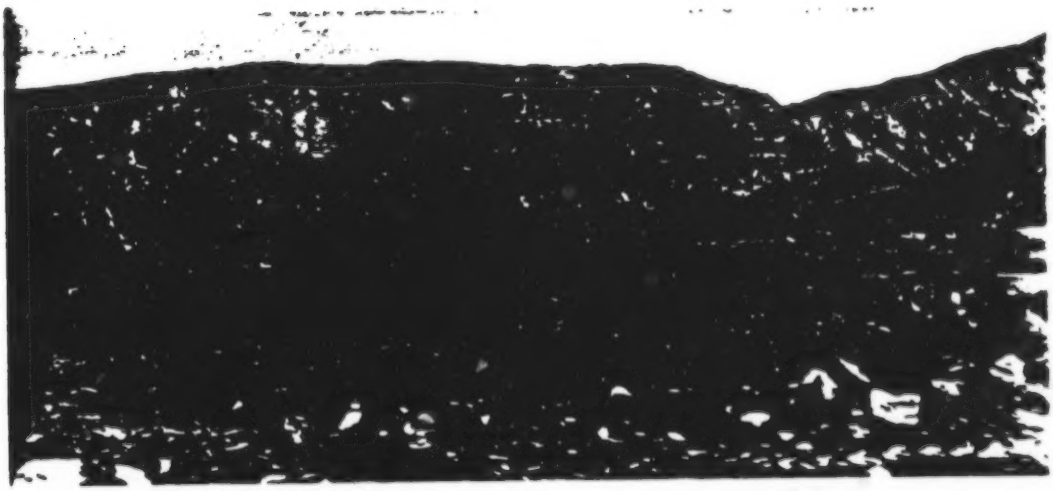

Fig. 11. View of the Main Pit

Fig. 12. Moving of Shovel from the Main Pit

DESCRIPTION OF TRUCK DISPATCHING SYSTEMS

IOC Mine DISPATCH System

At the visited mine, DISPATCH system developed by Modular Mining System of Tuscon, Arizona, is used. A Digital Corporation's Vax 11/750 computer with 3 Mb of memory was assigned to the system. Two high-speed (9,600 baud) lines drive CRT terminals: one for key transactions and error messages to the dispatcher, the second to access system utility programs and status displays. The third port is usually used to drive a printer for a summary at the end of each shift. The fourth port drives a Motorola 6802 microprocessor-based DISPATCH master panel. The communication between the panel and the computer is in the form of ASCII character strings.

Each truck and shovel, and crusher uses a Motorola 6802 microprocessor-based control console and a Motorola Mitrek UHF FM radio to communicate with a repeater tover, that in turn, communicates with the radio-equipped master DISPATCH panel. Each microprocessor-based control console includes 2 Kb of erasable programmable read-only memory (EPROM) for program storage and 128 bytes of random access memory (RAM) for temporary storage. Field messages are 8 bytes in length and are transmitted at 600 baud.

At each shovel, dump and crusher, as well as at selected points along the haul roads, location beacons or sign posts are installed. These units consist of a solar panel and three circuit boards, all mounted in a stainless steel tube 80 mm in diameter and 1.2 m long, installed on poles between 2 to 5 m above the road surface. Typical sign post with the solar panel is shown in Figure 13.

Software for all field panels was written in Motorola 6802 assembly language. Dispatch programs, such as the interactive PITSET sub-system, and tasks, such as the DISPATCH executive, were developed in VAX 11 Fortran - a superset of ANSI 1978 Fortran. All software sub-systems are modular and well

Fig. 13. DISPATCH System Sign Post

structured. Over 50,000 lines of source code and system command procedures constitute Version 2.0 of Dispatch. Fig. 14 presents an overview of the system functions and field interaction (1).

Detached DISPATCH process and interactive sub-systems are supported by the data base. Key information on equipment, routing, material, employees, fuel parameters, current and cumulative production and time statistics, node queues, action sequencing, and the LP model solutions, are maintained here for access by all sub-systems. The global data base is accessed by a mine planning group to effect changes in pit topography and other key system parameters that should not be modified by the dispatcher. DISPATCH also maintains shift and monthly data files for use in report generation and production performance analysis.

DISPATCH system begins execution of the program automatically after shut down condition for periodic hardware maintenance. Two main interactive sub-systems have the following function:

1. PITSET sub-system, that serves four principal functions: initial pit layout, set-up of the proposed pit layout for production forecasting and simulation, restoration of a DISPATCH global data base from the disk, and modification of shared data-base parameters. By using PITSET, pit nodes may be created, deleted or modified, travel times and distances may be modified for use in simulation studies, and data may be printed for examination.

2. UTILITY sub-system, that may be used to monitor mine operation, or assign DISPATCH startup and operating parameters. Certain utilities, such as confidential management files, are accessible through assigned passwords only.

The key input data required by all utilities are maintained automatically in real-time by the system.

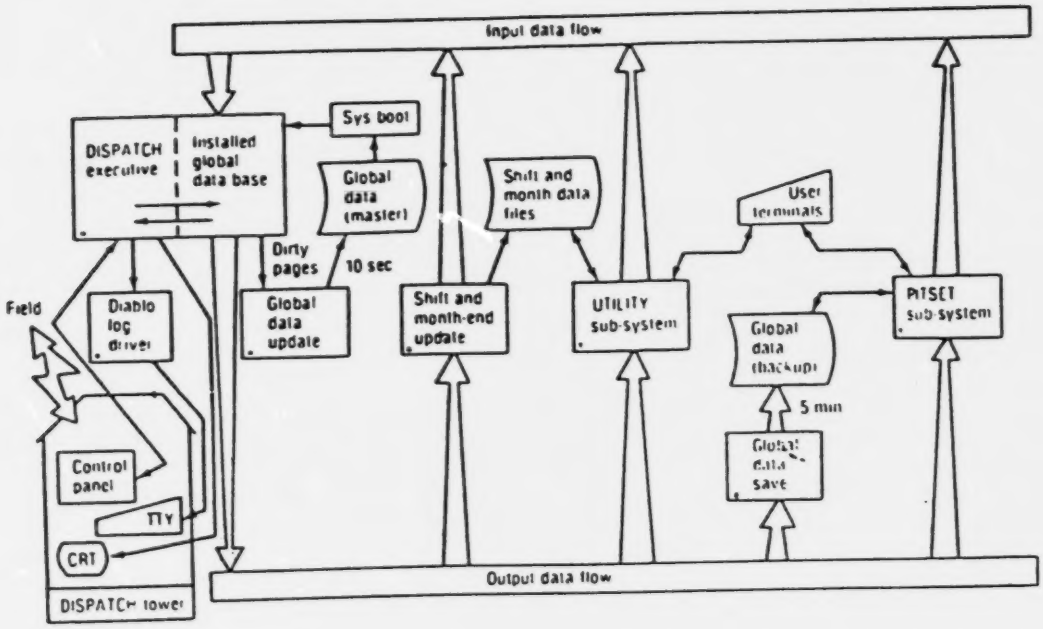

Fig. 14. Overview of DISPATCH System Functions

DISPATCH utilizes dump to shovel proximities to optimize the haul routes in the mine. The pit disturbances are monitored and the haulage flow pattern is dynamically adjusted to match the current conditions in the mine. The flow rate of trucks to shovels is based on the shovel priority designation. In overtrucked operation the system recommends either parking trucks or readying standby shovels.

DISPATCH includes an event-based simulation subsystem based on real-time data collected during normal operation. New dump placement or shovel moves may then be predicted and effect of delays on a production investigated.

Performance data can be evaluated by using a shift and multi-shift reporting of truck and shovel productivity. Complete equipment performance statistics, such as availabilities and utilizations, are supported on an individual equipment basis, by fleet, and/or by equipment size. Down times of all equipment may be evaluated and life span and future performance predicted. The management is provided with a tool to determine efficiencies of the mine equipment. Unproductive shovels and slow moving trucks, for example, may be identified. Each segment of the haulage cycle is analysed to allow management to evaluate performance against mine standards.

During a regular run, a truck driver has buttons to:

-request an assignment,
-indicate arrival at the destination,
-indicate commencement of loading,
-indicate that the truck is either down, delayed or on standby,
-indicate that the truck is ready,
-indicate obstruction or spillage on the road at his present location,
-call for help,
-recall the previous message, and
-give numeric codes to dispatcher (his ID, etc.).

The truck driver console is illustrated in Fig. 15.

The shovel operator has a similar console as the truck driver (Figure 16). In addition he may indicate whether he is digging ore or waste or is moving the shovel. When truck loading is completed, the operator depresses a footswitch which activates the 'OK' function.

The DISPATCH utilities are accessed through the keypad of a computer terminal and were described previously. Four screens are at the dispatcher's disposal. The first is a transaction screen which displays regular events for information only. It does not demand a response. The second screen is the exception screen to display transactions of exceptional nature and which require response from the base operator. The third screen is the utility screen for recalling the utility commands. Last screen is the colour graphics screen displaying the location of each equipment in the mine. The haul routes are shown with the number of trucks moving along each route. All equipment is colour coded to indicate status and the type of material being dug or transported. Zoom features of the terminal allow for a detailed examination of congested areas.

Wabush Mine Proposed PMCS's System.

The Production Monitor and Control System (PMCS), developed by Wenco International Mining System of Vancouver, B.C. is proposed to be installed at the mine later this year. Initially it will be on trial basis for the period of three months. If the system proved to be successful (8 to 10 % in production improvement), the system will be permanently installed for all mine trucks.

The proposed PMCS system consists of four components (2):

1. Pit control,
2. Truck dispatch,

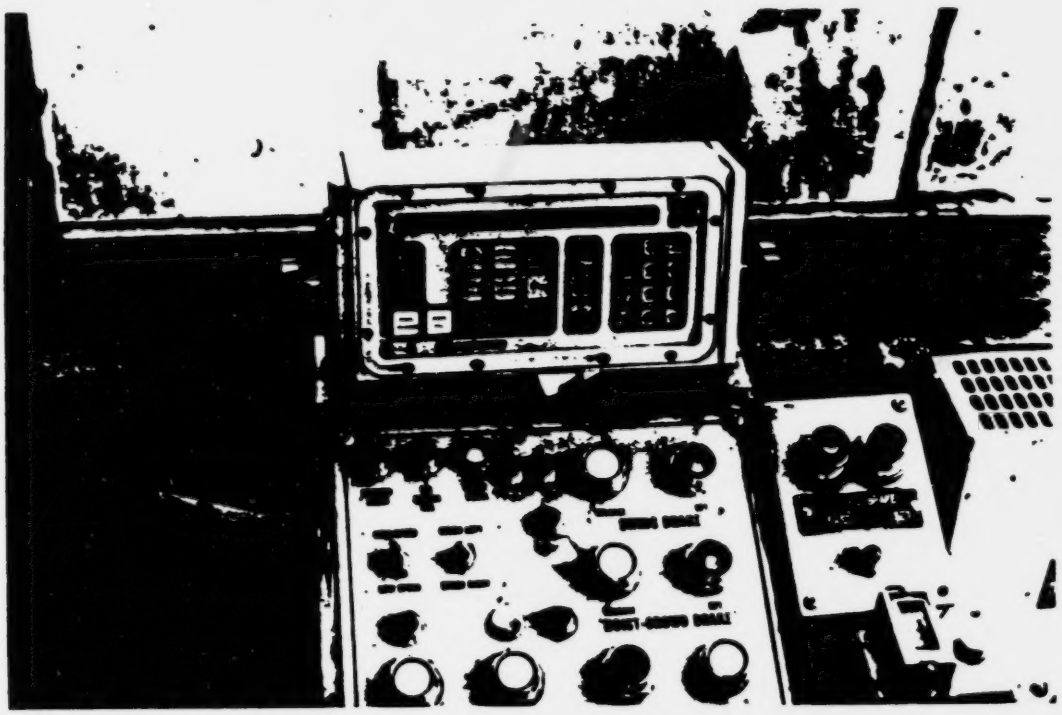

Fig. 15. Shovel Operator DISPATCH System Console

Fig. 16. Truck Operator DISPATCH System Console

3. Management information, and
4. Data Communication.

The PMCS is comprised of custom designed data gathering and encoding hardware with the ability to receive and transmit data mounted in production equipment, radio repeaters when needed, a radio communications system interface, a twin microcomputer based dispatcher and pit monitor display, and a similar microcomputer that provides current and historic management information.

Equipment operators are provided with a dash mounted dataset with several function keys that they will touch at certain points in each production cycle. The signals generated are received by a custom designed modem that translates messages between the languages of the base radio and the computer. The modem continuously runs a firmware set whose function is to determine that the message received is meaningful and to accept and acknowledge valid messages. These messages are then passed on to the Monitor computer.

Where there is a need, optional fixed point location monitoring functions are used to validate or extend the information available to the system. To automatically trigger a shovel assignment is a typical use of this function.

PIT CONTROL

The MONITOR computer is the heart of PMCS. It is the main interface between PIT CONTROL, who acts as the dispatcher, and mine staff. It gathers operational data, dispatches hauling equipment, relays pit controller's instructions, display events and status, produces printed shift records, tracks progress towards production plans and plant feed, and passes data to other systems.

From the radio signals sent by mining equipment and other information at its disposal, MONITOR is able to provide a remarkable amount of operational information. These include material movements by volume and weight, loading times, travelling times both empty and loaded, delays and standby times. Items are gathered, stored and accumulated on a unit by unit basis, and can be reported for individual equipment, by fleet or for the mine. Information derived from the data collected are divided into several categories, such as operating indicators, performance indicators, and production statistics. The MONITOR is able to predict equipment and production needs on a minute by minute basis.

The PIT CONTROL is providing the following functions of the system:

Events and Status Information. Current status of production this shift by material type, machine, location, is displayed. Information is provided on operational indicators, such as delays, waiting times, stockpile levels, product blend, equipment status.

Relays Instructions. The radio data link handles two way traffic. Reassignments by the dispatcher are displayed on the mobile dataset, with an allerting tone to attract operator's attentions.

Shift Records. At shift end, PIT CONTROL receives reports detailing Events and Status Information plus report on productivity, availability and utilization by fleet and unit, and location and status of each equipment unit. The shift records are made available to the MANAGEMENT INFORMATION SYSTEM (MIS) and can be transmitted to other data processing systems according to the mine's needs.

Tracks Progress. MONITOR reports production shift-to-date, by location and material, and forecast the total production to be achieved by the end of shift. The PIT CONTROL can see whether the shift objectives are being met, and take corrective action if they are not.

Tracks Blend. MONITOR maintains a running record of the material fed to the mill or other designated location. This is reported both on an absolute and relative basis from the start of the shift or change in specified blend.

Passes Data to Other Systems. The detailed record of events occuring during the shift is passed to the MIS component of PMCS or any other external system after the end of the shift.

TRUCK DISPATCH

This fully automated function of the PMCS system, called DISPATCHER, offers the following features:

Easy to Use. Truck dispatching can be engaged or disengaged for all available shovels and trucks. The DISPATCHER provides the PIT CONTROL supervisor with information regarding its decisions as they are made. These dispatch commands are automatically logged for future reference. Notice of dispatch is sent to the truck via radio link. The driver interface is simple and reliable. An alerting tone sounds, and the new assignment is displayed on the data panel of the truck's mobile dataset.

Easily Adapted and Controlled. PIT CONTROL can start automatic dispatching of trucks, stop it, or change the operating parameters. Minimum training to perform this function is required. Several different dispatching strategies can be operated simultaneously. If required, some equipment can be operated with and some without automatic dispatching at the same time. Reassignment of trucks already dispatched, when a shovel goes down or is delayed, may be handled automatically by the computer, or may be manually controlled at the discretion of PIT CONTROL supervisor.

Effective. The DISPATCHER after installation in the mines proved to be immediatelly effective by increasing productivity. Available productivity

gains are directly related to the amount of waiting time previously experienced by trucks and shovels at the mine.

Stable. The dispatching decisions are based upon intelligent interpretations of current data. Changes such as moved shovels, new equipment status and other events ar handled correctly. Dispatcher deals effectively with mixed fleets of haulers, and is not fooled into making poor decisions by a mix of truck speeds and capacities. Trucks are evenly dispatched to best serve the available shovels, even during the startup, shift change, or other non-standard conditions.

The DISPATCHER requires the selection of the integral data radio option to be installed. Datasets are model MCR1A rather then the standard MCU1A in the data communication network.

MANAGEMENT INFORMATION SYSTEM.

The MIS provides mine manager and engineers with more then two hundred graphic displays, as well as access to detailed operating data. The graphics are rendered in high resolution and full colour to give an instant visual picture of the mine's activities up to the last full day of operations. The types of information derived include mine summary, production, productivity, availability, utilization, and operational analysis. The example of menu hierarchy is enclosed in Figure 17. Next Figures show examples of other graphics display capabilities of MIS. Figure 17 is the example of variance from planned production (in %), Figure 18 illustrate down time monthly analysis of Terex 33-15C truck, Figure 19 shows daily and cumulative rock production for specified period (week in this example), and Figure 20 displays analysis of equipment net operating hours.

Because MIS has such a large number of displays, a special menu oriented system called VIEWER has been created to store and retrieve them.

MENU HIERARCHY – Example list of PMCS displays

- MAIN menu
  - MINE SUMMARY
    - Compared to PLAN
    - Compared to BASELINE
      - See TABULAR Report
  - PRODUCTION
    - COAL
    - ROCK
    - DRILLING
      - Last 7 DAYS, Cummulative WEEK
      - Last 30 DAYS, Cummulative MONTH
      - Last 12 MONTHS, Cummulative YEAR
        - See TABULAR Report
  - PRODUCTIVITY
    - P&H 1900 SHOVELS
    - TEREX 33-15C TRUCKS
    - EUCLID R100 TRUCKS
    - 250 mm DRILLS
      - See TABULAR Report
  - AVAILABILITY
    - TOTAL MINE
    - P&H 1900 SHOVELS
    - TEREX 33-15C TRUCKS
    - EUCLID R100 TRUCKS
    - 250 mm DRILLS
      - YESTERDAY
      - MONTH TO DATE
      - YEAR TO DATE
        - DOWNTIME ANALYSIS
          - See TABULAR Report
  - UTILIZATION
    - TOTAL MINE
    - P&H 1900 SHOVELS
    - TEREX 33-15C TRUCKS
    - EUCLID R100 TRUCKS
    - 250 mm DRILLS
      - YESTERDAY
      - MONTH TO DATE
      - YEAR TO DATE
        - DELAY ANALYSIS
          - See TABULAR Report
  - INVENTORIES
    - EIGHT SEAM
    - C SEAM
    - TEN SEAM
      - See TABULAR Report

Fig. 17. PMCS Menu Hierarchy

Wenco International

Down Time Analysis - Terex 33-15C Truck
For the Month to 30APR86

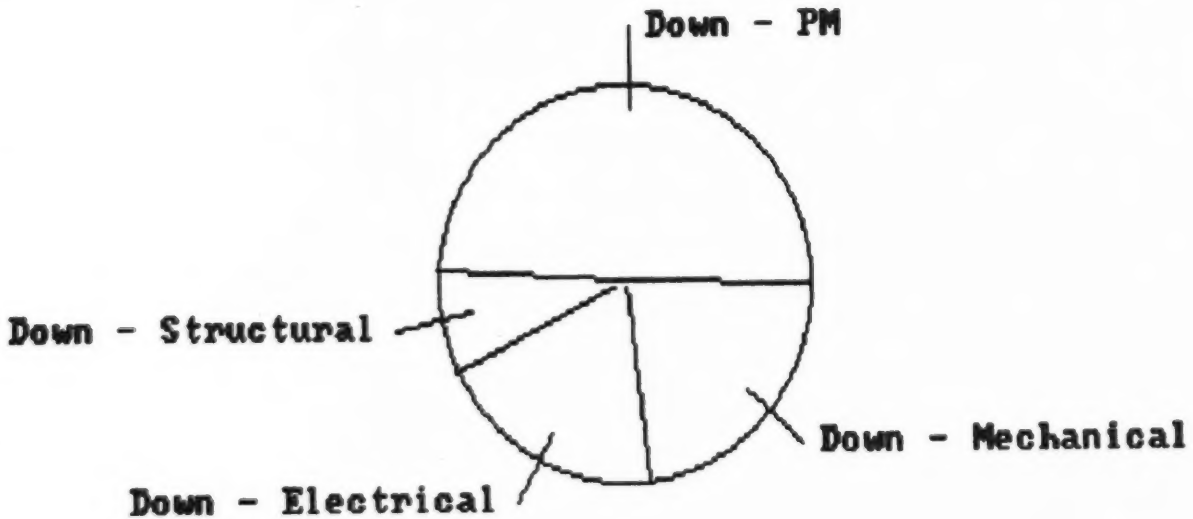

Fig. 18. PMCS - Down Time Analysis Report

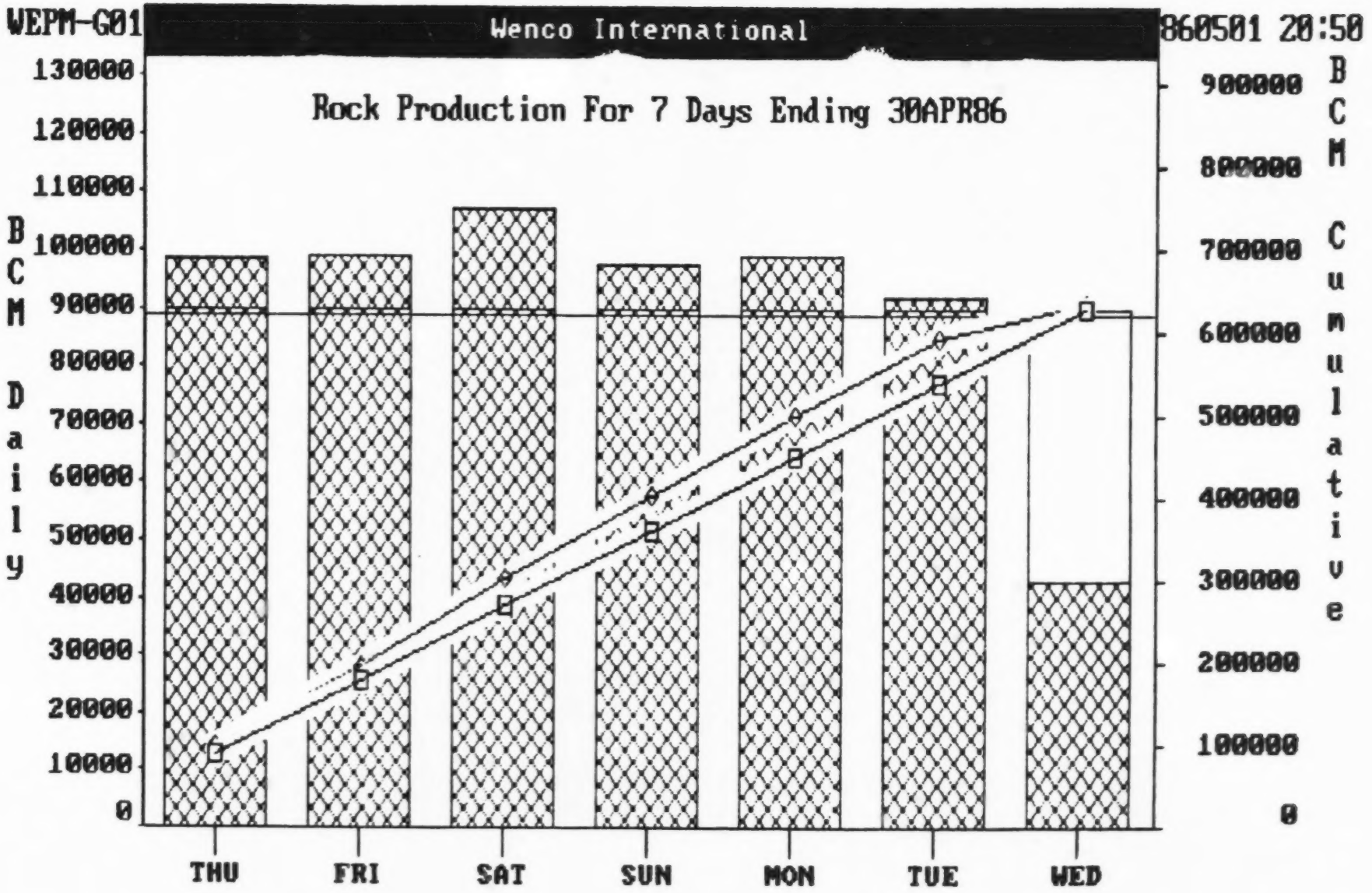

Fig. 19. PMCS - Rock Production Report

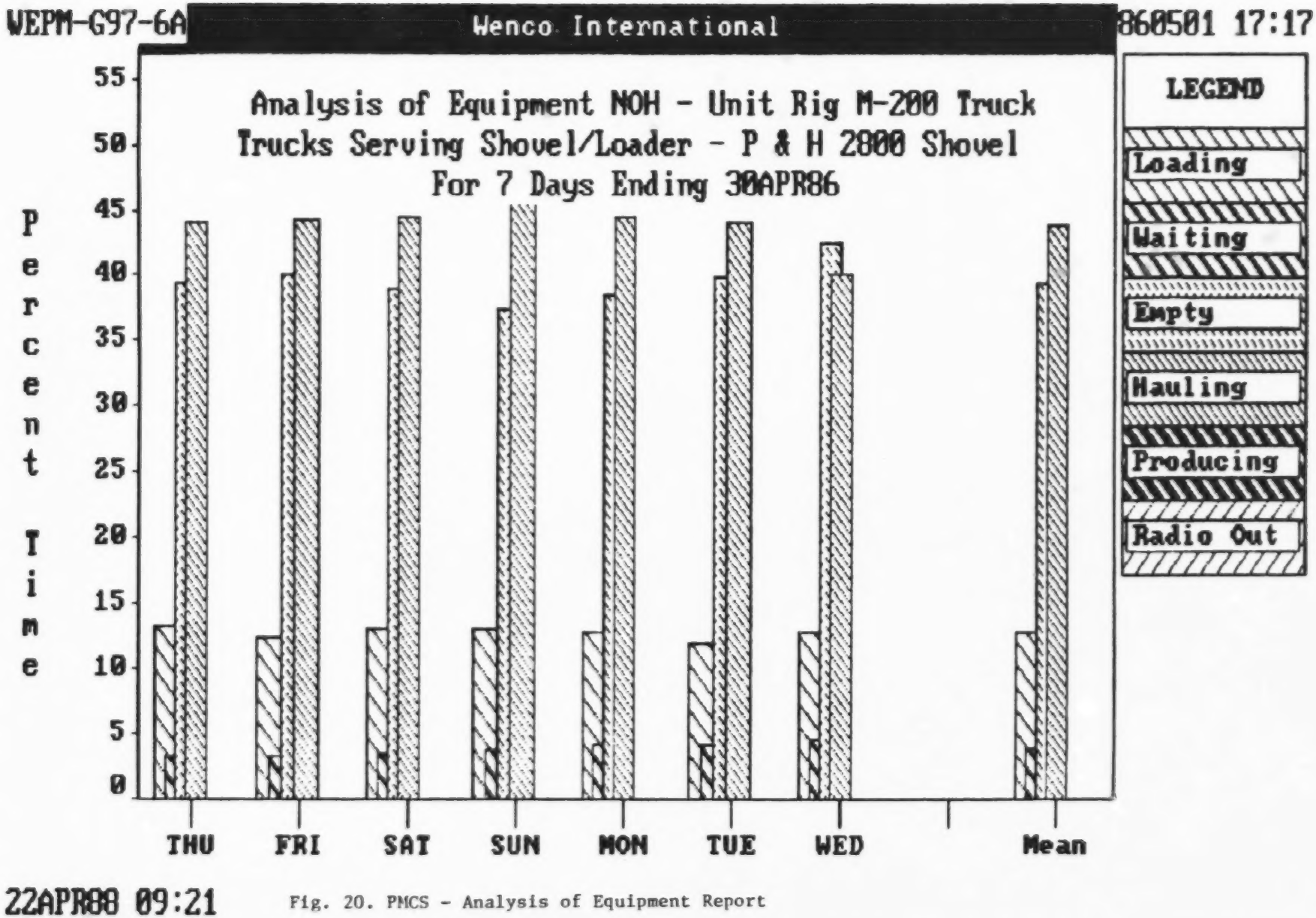

Fig. 20. PMCS - Analysis of Equipment Report

The displays are arranged into a logical sequence, according to each individual mine's requirements, so that a user can move quickly from one area of interest to the next.

The MIS and MONITOR are thoroughly integrated and use the same framevork of information. The mine is described to PMCS as a series of tables such as Equipment Units, Mining Locations, Mined Materials. The tables are used by both MONITOR and MIS to ensure that data flow between them is properly interpreted.

DATA COMMUNICATIONS.

The MCR1A mobile data terminal is a self contained CMOS microprocessor based device designed specifically to meet the data acquisition needs of the PMCS. Is installed in a haul truck, or other piece of mining equipment, and provides a digital communication link between the equipment operator and the computer. Dtyya is entered and edited by means of a dedicated keypad and is displayed on a five digit LED readout. In addition to sending messages to the PIT CONTROL computer, the MCR1A is able to receive messages which are displayed in the same fashion.

The keypad is of a sealed membrane switch type, and is comprised of 20 large keys which are colour coded in relation to the type of function each performs. The dataset emits an audible beep each time a key is pressed. Eight of the keys are used to indicate operating status. They are marked with indicator lights to show which status is nov active. Ten keys are used for entering numeric data, one key is used to clear or correct onformation before it is sent and one key is used to transmit the data.

Other information such as DELAY codes, MODE codes and HELP status are entered on the keypad in the same way. An exception in the way these are handled is the help key which, when pressed, will cause the unit to emit a vail tonewhich will continue until the SEND or C/CE key is pressed or an

internal timer expires. Of course, activating the HELP key will get the immediate attention of the PIT CONTROL supervisor.

Other features of the MCR1A include two modes of operation which assist service personnel in the installation, setup and maintenance of the system. A PROGRAM mode is available to set the unit's own unique address, which identifies this unit from other units in the system. This along with other parameters that customize the MCR1A to the requirements of each system, are entered through the keypad while in PROGRAM mode. This method of customization precludes the use of special programmer units often associated with devices of this kind. Such information is stored indefinitely, or can be revised at will. Another mode of operation is the SERVICE mode. This mode permits service staff to perform setup tests and diagnostic routines to aid in the installation and maintenance of the system.

The RM110 Radio Modem serves as an intelligent interface between the PMCS MONITOR computer and the MCR1A mobile data terminals mounted in production equipment. Radio system data transmitted and received by the RM110 is maintained under full control of the MONITOR computer. An internal high speed data radio provides a link to the mobile data terminals in the mine. Communication with the host computer is accomplished via a standars RS-232C port which is internally selectable from 120 to 9600 baund. Data messages are validated and formated by the RM110 to suit the needs of the radio system. A two line by 40 character LCD display module presents both transmitted and received messages as well as the status of input and output ports. A single eight bit input port and a similar output port are available as undedicated ports for direct control by the host computer.

The internal high speed data radio can optionally be interfaces with a radio repeater or replaced by a more powerfull base station radio depending on radio conditions in the area of installations.

A specification of Data Communication system is in Table 2 (2).

Table 2. PMCS - Data Communication Specification

Specifications @25°C, 13.8vDC

RM110 RS-232 protocol	**selectable 120 to 9600 baud**
	7 or 8 data bits, no parity
	1 stop bit.
	hardware handshaking available
Aux. output bits 1 to 8	open collector active low
Aux. input bits 1 to 8	open to 1V low, 4 to 18V high
Transmit buffer	2048 characters
Receive buffer	2048 characters
General:	
Power supply	8 to 18 VDC, 13.8 VDC typ.
Operating Temperature range	-30 degrees C to +80 degrees C
Antenna impedance	50 ohms unbalanced
Humidity	90% non-condensing
Frequency range VHF	150 to 174 MHz
UHF	450 to 470 MHz
Frequency stability VHF & UHF	+/- 0.0005%
Frequency control	Quartz crystal
Channel capacity	1 simplex or half duplex
Radio Receiver	
Sensitivity	0.35 uV or better (12dB SINAD)
Noise quieting	20dB or better @ 0.5 uV
Receiver recovery after PTT	18 mS or less
Modulation acceptance bandwidth	+/- 7.0kHz
Spurious and image rejection	at least -70dB
Intermodulation rejection	at least -60 dB
Selectivity	at least -75dB +/- 25kHz
Radio Transmitter	
Carrier power output	5 watts @ 13.8VDC
Modulation system	Direct FM, 16F3
FM hum and noise	at least -50dB down
Spurious and harmonic emissions	less than -60dB
Maximum deviation	at least +/- 5kHz
Attack time	less than 50 mS
HSC Decoder	
Input sensitivity	min 0.04VRMS max 1.0VRMS
Minimum decorder bandwidth	+/- 20Hz
Signal to noise ratio	min 3.0dB typ. 0dB
CTCSS rejection	20dB
Input impedance	150k
HSC Encoder	
Maximum output level	0dBm
Output impedance	1.0k
Tone frequency stability	0.005%
Total harmonic distortion	2.0%
Output level variation	0.3dB typ.
Tone period	33.0 mS typ.
Pre-transmit delay (MCR1A)	10 ms - 9.99 sec
Pre-transmit delay (RM110)	30 ms - 4.00 sec
Post-transmit delay (RM110)	30 ms - 4.00 sec
Inter address delay (RM110)	30 ms - 4.00 sec

According to the mine engineer, the PMCS system was selected for an initial testing at Wabush mine for the following reasons:

- monitoring, control and dispatch function are in real time,
- broad range of informations and reports,
- production information is accurate and timely,
- system is reliable with backup provided,
- ease of use at all levels from the equipment operator to the mine manager,
- modular design with a wide selection of system options,
- site specific flexibility,
- micro computer technology, and
- cost effective, offering prompt return of invested capital.

The benefits to the mine operations are seen as improved productivity, utilization and cost performance through:

- decision support for first line supervisors,
- automated truck dispatching to minimize waiting times,
- accurate control of product blend,
- accurate performance data for mine planning,
- direct feedback of results achieved at all levels from operator to superintendent,
- detailed operating time information used in the analysis of trends and in optimization studies,
- reduced manpower and equipment requirements, and
- elimination of effort in the acquisition and handling of data.

QCL's MWTD System.

The Mount Wright Truck Dispatching (MWTD) is the truck dispatching and automatic identification system designed by Systems Control of Palo Alto, California in 1977 and since updated and partially rewritten by the Ecole Polytechnique from Montreal.

The 'direct proximity' technique is used in identification of aproaching vehicles at strategic points, therefore very light, battery operated wayside transmitters with fix locations are provided through the mine to indicate truck locations. One of the wayside transmitters is shown in Figure 21. The receivers, transmitters and logic control units are located on trucks.

Trucks are located by means of wayside transmitters that emit a location code that is picked up by the truck receiver as the truck travels along. The code is stored in a memory in the truck mounted equipment and upon receipt of a radio signal from the computer location this code, plus a truck identification code is transmitted to the computer. This is done on a regular scanning cycle basis where the entire truck fleet in operation is scanned approximately every 2 seconds. The wayside transmitters are stored in 20 x 15 x 10 cm boxes weighting 2.2 kg, intermittently emitting at 27 MHz. One each is mounted at every shovel, each dump, crusher, agregate plant, fuel station, and the pit entrance. They all emit an unique 8 bit serial digital message. Seven bits are used for sensor identification and one to indicate the truck location. The system has a capacity of up to 128 wayside transmitters.

A truck control logic unit senses its proximity to an identification emitter when the received signal level in the truck receiver exceeds a treshold V_1. If the location bit is a logical (0) than this identifies a roadside emitter. The truck unit will then store the I.D. code in a location register memory, replacing any previously stored different location identification (3).

If the location bit is a logical (1), this identifies a loading point. If the treshold V_1 is exceeded, the system will then make an integration adjustable from one to sixteen continuous identification messages. After the integration has been successfully completed the truck unit will store the I.D. code in the location register as an arrival, replacing the previous

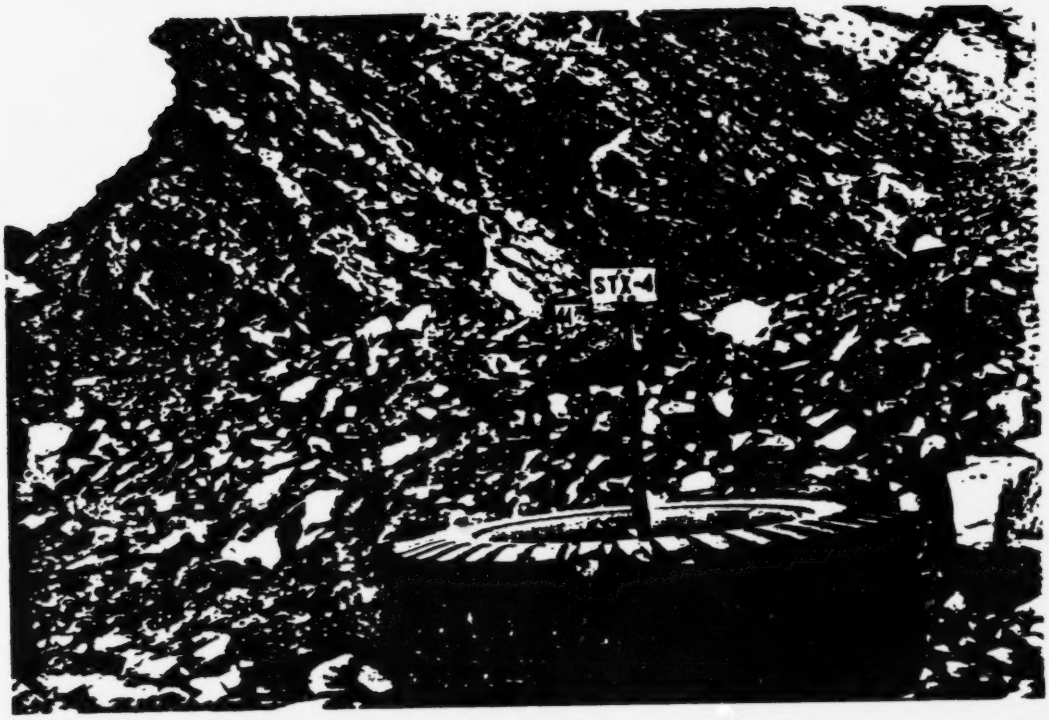

Fig. 21. QCL's Wayside Transmitter

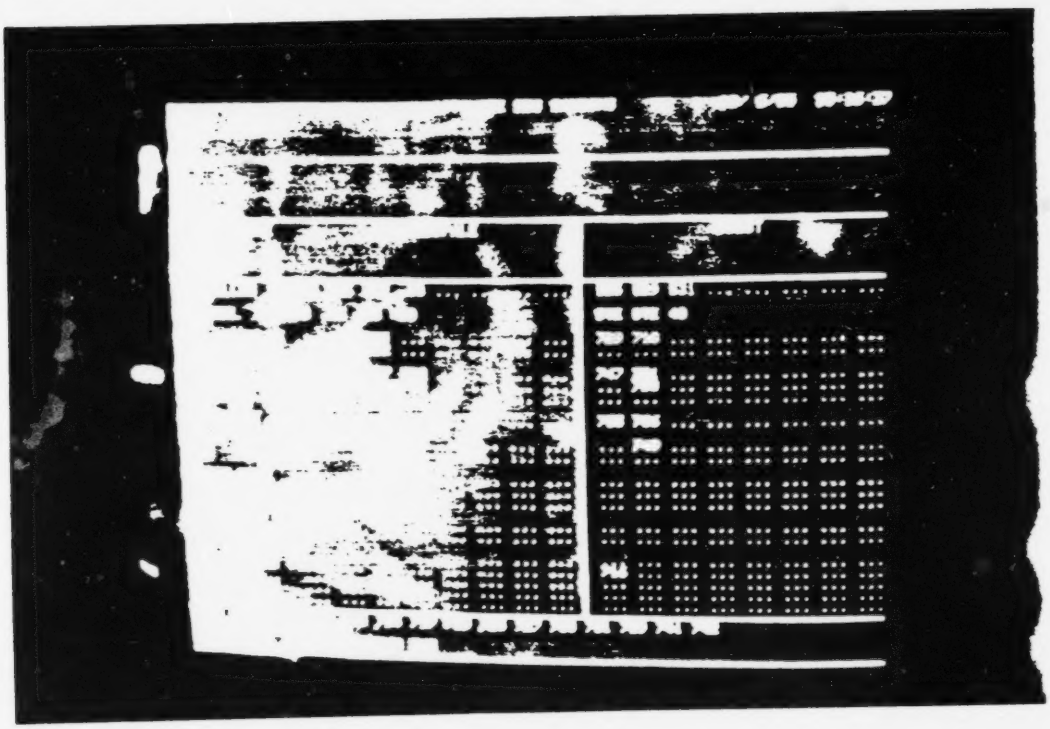

Fig. 23. QCL's Truck Status Display

one. This I.D. code will, upon scanning request, inform the computer that the truck has arrived at a shovel or front-end loader location. All of this integration procedure is necessary to compensate for the changing position of the transmitter as the shovel or loader moves during loading.

In order to report a departure from a loading location, the truck equipment must previously have stored an 'arrival' in its register, then reach treshold level V_2. The integration procedure is repeated as the truck moves away and finally the departure is stored in the memory, which is transmitted on receipt of a scanning request. Figure 22 is illustrating range boundaries of the truck logic control (3).

Since the dispatcher can not see most of the haulage roads in the mine, the computer also keeps track of average cycle time of the last five trucks that travelled between each pair of wayside emitters. If a truck has failed to show up at an expected emitter within a certain range above the average, the controller is alerted and can check by voice radio to see what is going wrong. Only the last five trucks are used to compute the average, in order to allow for quick changes in cycle time usually associated with changes in climatic conditions at the mine.

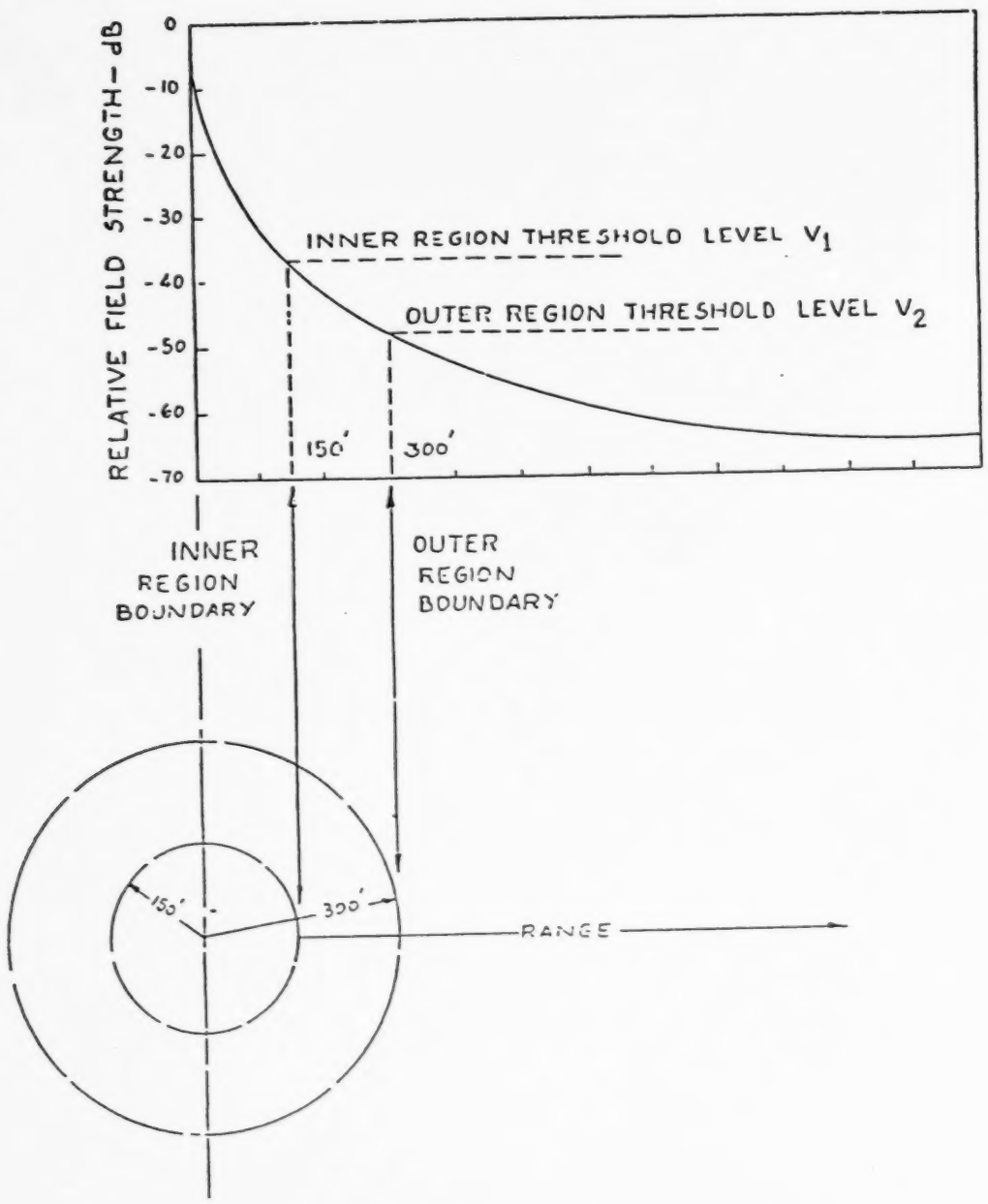

Fig. 22. Range Boundaries of the Truck Logic Control

HARDWARE

The system consist of a wayside emitters, truck mounted receivers, and computer operating system. The computer is a Digital Equipment PDP-11 micro with 64 K memory, having one fixed hard disk and two moving hard disks for auxiliary memories. Spare, identical computer, is kept as stand-by. It is used for constant checks of the operating system of the first computer. This redundancy is required to assure system reliability. The operating system used is RSX-11M from Digital. It is a real time, even driven system, allowing for multiple tasks to be done simultaneously by tagging each one with a level of priority that commands which job must be done first. The system also allows programming in Fortran.

The computer system has two dispatcher terminals located in the dispatcher building:

- two color CRT's from Intelligent System Corporation, one being used to show production figures and the other to watch truck movements,
- two teleprinters (LA-36 from Digital), one is used for report generation and one to keep record of information fed to the system by dispatcher.

COMMUNICATION

Trucks are equipped to be able to communicate directly with the computer. On each truck there is:

- a 27 MHz receiver to handle the wayside communication,
- an UHF renge receiver and transmitter to accept and send information on scanning request to the computer via the base repeater system,
- a logic control unit, and
- a LED display on the truck console to provide driver with instructions.

The first three of these items are stored in a 60 x 60 x 20 cm heated box mounted on the truck catwalk.

The truck sends its message in about 30ms. It also requires 30 ms to 'turn on' its transmitters and 30 ms to 'turn off'. This means that polling each truct takes 90 ms. Every truck is therefore scanned every 2.5 sec assuming there are 28 trucks operational.

Computer commands to be given to the truck driver are done through the same channel. Only the truck concerned can process the message and show it on the truck display panel inside the driver's cab. This consists of a two digit number coded for shovel assignment, fuel, lunch, crew change, etc.

SOFTWARE

The dispatching is done in the following manner:

When a truck has dumped its load into the crusher, it is first assigned to a pit to go to, either Main or West. The computer calculates the difference between the number of trucks that are serving each pit and the number of trucks each pit would theoretically require, to determine pit needs. The theoretical need of a pit is the sum of the theoretical needs of each shovel within the pit. The shovel theoretical need is the ratio of the truck cycle time and the loading time.

The truck is assigned to a shovel only after it actually entered the pit. At the pit entrance the truck will be dispatched according to the minimum waiting time. The shovel first selected would be the one having no truck waiting or being loaded. Otherwise the shovel with minimum travelling, loading and waiting time would be selected. To be able to calculate the waiting time at any shovel, the computer, every time it assigns a truck to a shovel, also calculates when this truck will be leaving its assigned shovel.

This calculation is based on latest average cycle time between any two wayside emitters.

The trucks are not dispatched to a shovel directly from the crusher in order to improve accuracy of the data. Between the crusher and the West pit entrance is about 10 minutes travel time, so by assigning a loading place to a truck only at the pit entrance, it is assumed that nobody is dispatched to a shovel that could breakdown during the travel time from crusher to pit entrance. If a shovel breaks down, the dispatcher's intervention is required to activate a 'shovel diversion routing' program. Dispatcher's action can only take place after he has been notified by the section foreman of the disabled shovel. The diversion routine will automatically re-assign trucks that were on the way to the 'down' shovel, based on minimum waiting time, within the same pit.

The computer checks, calculate or update the following tasks for the trucks:

- truck status for operating hours,
- truck class for calculation of tonnage factor,
- next station to be met,
- projected arrival and departure time,
- last station met,
- actual departure time,
- material type hauled,
- fuel time remaining, and
- index for assigned route profile.

It also needs to build and check a shovel table which contains:

- material being loaded,
- average grade of ore,
- last assigned truck departure time, and
- loading time.

An interesting feature of the system is a new check of tire overheating. The computer will constantly check the TKPH factor and will notify the dispatcher when a fixed limit, below the manufacturer's recommended limit, is exceeded. At this point, the action to be taken will be to made a manual forced dispatch to a short waste haul to allow tires to cool. The computer is also linked to the crusher lines in order to automatically divert trucks to stockpile if crusher lines are not operating.

To help production meet the 31.4 % Fe daily blending target at the crusher, each shovel location grade is input into the system and every load dumped into the crusher builds up an average 'grade to date' that is displayed on controller's CRT. Thus average grade fed into the crusher is continuously known and action can be taken at any time to assure the target.

The dispatcher can also see the production figures like loads to crusher (or stockpile, dumps), tonnages, etc. on the same CRT, while on the other he can watch the truck movements and shovel status as well as individual truck productivity. Example of the CRT's display is shown on Figure 23.

REPORTING

All data of the mine activities are summarized automatically. Every time a truck dumps its load the production figure for this truck, for this dumping point, for the shovel, where it comes from and for the shift production, are increased by one load and transformed into tonnes using truck correction factor. Operating hours for truck and shovels, accurate production speed, accurate volumes of waste and ore, equipment availability and utilization and performance are all listed. Truck waiting times at shovels and shovel waiting time are also accumulated. These two sets of figures are a very important indication of the truck efficiency of the dispatching system.

At the end of the shift, production reports are printed and show all the figures required by engineering and production departments. Reports are also summed up for daily, weekly and monthly statements.

Figures 24 to 30 shows some examples of reports produced by the mine dispatch system.

CONCLUSION

The presented trip report provide overview of the iron ore mining practices at Labrador as were understand during the trip visit. In addition, dispatching systems used or planned to be used at three mines in Labrador are described.

The visit of the mines was beneficial from the technical point of view, because at three visited mines three different dispatching systems are employed. Knowledge gained during the visit will be used in evaluation and selection of the dispatching systems planned as one of the components of the Integrated Truck Management System, proposed to be developed for western Canadian coal or oil sands mines.

ACKNOWLEDGEMENT

The author is grateful to the engineers and management of all three mines who were frank and open in discussing their operations. Particularly Mr. M. Rogers, Mine Engineer - Dispatch System of Iron Ore Company, Mr. T. Watt, Mine Superintendent of Wabush mine and Mr. R. Pearson, Mine Superintendent of Quebec Cartier.

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CAMIONS	ETAT	HH:MM	NOTE
701	RESE	8:47	
702	RESE	0: 0	
704	OPER	18:12	
705	RESE	4: 0	
706	RESE	6: 3	
707	OPER	5:35	
712	OPER	7:13	
714	OPER	8: 3	
716	OPER	10:51	
717	OPER	8:52	
718	OPER	5:57	
719	OPER	10:27	
720	OPER	13: 9	
747	OPER	10: 8	
748	OPER	17:45	
749	OPER	7:41	
725	OPER	4:37	
726	OPER	14:23	
728	OPER	13:58	
729	OPER	4:38	
732	OPER	12:48	
734	OPER	17:44	
736	OPER	15:24	
738	OPER	6:23	
742	OPER	7:33	

25 CAMIONS

MAINT: 703 708 715 723 727 730 731 733 739 740
741 743

---> LOCATION DES PELLES <---

STE1: 526 527 528 536 537 61

STE2:

STE3: 525 529 531 533 542 535 60

STE4: 524

PELLE	ETAT	MATERIEL	TEN - REC	CHARGEMENT		BTAIS
MINE PRINCIPALE						
528	OPER	MINE	36.0	47.1	4.5	0
536	OPER	STER	33.9	75.6	4.6	0
537	OPER	STER	22.1	24.5	5.1	0
MINE OUEST						
529	OPER	MINE	30.0	38.0	5.2	0
533	OPER	MINE	37.9	50.1	4.9	0

MAINT: 524 525 526 527 530 531 542 535 60

Fig. 24. QCL's Equipment Report

TEMPS DE CYCLE

MINE PRINCIPALE

# DE PELLE	DEST.	CHARG. SEC.	CHARG. MIN.	BIAIS	CYCLE SEC.	CYCLE MIN.
526	33	390	6.5	0	1074	17.9
527	33	354	5.9	0	936	15.6
528	33	288	4.8	0	1086	18.1
536	24	294	4.9	0	1056	17.6
537	24	282	4.7	0	1074	17.9
61	24	492	8.2	0	1266	21.1

****

MINE OUEST

# DE PELLE	DEST.	CHARG. SEC.	CHARG. MIN.	BIAIS	CYCLE SEC.	CYCLE MIN.
524	26	342	5.7	0	906	15.1
525	26	360	6.0	0	738	12.3
529	33	288	4.8	0	1170	19.5
530	77	372	6.2	0	870	14.5
531	33	486	8.1	0	1470	24.5
532	77	450	7.5	0	1476	24.6
533	33	390	6.5	0	1338	22.3
534	77	450	7.5	0	1476	24.6
542	26	246	4.1	0	828	13.8
535	33	468	7.8	0	1482	24.7
60	33	714	11.9	0	1728	28.8

****

TTO -- STOP
>

Fig. 25. QCL's Cycle Time Report

PRODUCTION

		MINE PRINCIPALE JOUR	MINE PRINCIPALE MOIS A DATE	MINE OUEST JOUR	MINE OUEST MOIS A DATE	TOTAL JOUR	TOTAL MOIS A DATE
VOLUME	MINERAI (%)	53.	34.	47.	66.		
	ROCHE (%)	45.	26.	55.	74.		
VOLUME	MINERAI (M.C.)	14952.	100755.	13058.	192753.	28009.	293508.
	ROCHE (M.C.)	9155.	45156.	11276.	129741.	20431.	174897.
	SURFACE (M.C.)	0.	0.	0.	0.	0.	0.
	TOTAL PRODUIT	24106.	145911.	24334.	322493.	48440.	468405.
	NON-PRODUCTION					85.	6946.
	DE LA PILE					0.	4418.
	AGREGAT					0.	0.
	TOTAL TRANSP					48525.	479769.
VOYAGES	MINERAI	379.	2554.	331.	4886.	710.	7440.
	ROCHE	198.	964.	242.	2744.	440.	3708.
	SURFACE	0.	0.	0.	0.	0.	0.
	TOTAL PRODUIT	577.	3518.	573.	7630.	1150.	11148.
	NON-PRODUCTION					2	148
	DE LA PILE					0	112.
	AGREGAT					0	0.
	TOTAL TRANSPORTE					1152	11408.

MOYENNE DE PELLES	2.5	2.3	4.7
MOYENNE DES CHARGEUSES			0.7
MOYENNE DE CAMIONS			21.6

	LIGNE 1	LIGNE 2	TOTAL
CONCASSEUR HORS D'USAGE	17.0	2.7	19.7
ATTENTE AU CONCASSEUR (HRES)			6

BARRIERE MINERAI	TEL. 222 AVANT 03:00		710.
STERILE			440.

Fig. 26. QCL's Pit Production Report

PERFORMANCE DES PELLES

NO DE PELLES	VITESSE	VOLUME TOTAL	VOLUME MIN	VOLUME STE	VOLUME SUR	VOY TOTAL	VOY MIN	VOY STE	VOY SUR	HEURES BRUTES	HEURES RESERVE	HEURES PANNES	DELAIS MINEURS	DISPONIBILITE		UTILISATION	
(#)	(MC/HR)	(M.C.)	(M.C)	(M.C)	(M.C)	(#)	(#)	(#)	(#)	(HRES)	(HRES)	(HRES)	(HRES)	(#)	(%)	(#)	(%)
524	0.0	0.	0.	0.	0.	0	0	0	0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0
525	418.8	7664.	2288.	5376.	0.	175	58	117	0	18.3	0.0	5.7	1.5	18.3	76.2	18.3	100.0
526	0.0	0.	0.	0.	0.	0	0	0	0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0
527	0.0	254.	0.	254.	0.	6	0	6	0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0
528	351.8	5735.	4438.	1277.	0.	140	113	27	0	16.3	0.0	7.7	1.1	16.3	67.9	16.3	100.0
529	443.9	8656.	4537.	4120.	0.	198	115	83	0	19.5	0.1	4.4	1.3	19.6	81.7	19.5	99.5
531	390.4	3787.	3787.	0.	0.	96	96	0	0	9.7	0.0	14.3	1.1	9.7	40.4	9.7	100.0
533	285.3	1854.	1854.	0.	0.	47	47	0	0	6.5	0.0	17.5	1.4	6.5	27.1	6.5	100.0
542	0.0	0.	0.	0.	0.	0	0	0	0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0
535	0.0	0.	0.	0.	0.	0	0	0	0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0
536	427.0	8070.	6588.	1482.	0.	198	167	31	0	18.9	0.0	5.1	2.5	18.9	78.8	18.9	100.0
537	393.2	9397.	3511.	5886.	0.	217	89	128	0	23.9	0.1	0.0	1.5	24.0	100.0	23.9	99.5
60	187.1	3106.	986.	2120.	0.	75	25	50	0	16.6	0.0	7.4	2.5	16.6	69.2	16.6	100.0
61	0.0	0.	0.	0.	0.	0	0	0	0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0

Fig. 27. QCL's Hourly Production Report

PELLES

TYPE	VITESSE (MC/HR)	VOLUME TOTAL (M.C)	VOLUME MIN (M.C)	VOLUME STE (M.C.)	VOLUME SUR (M.C.)	VOY TOTAL (#)	VOY MIN (#)	VOY STE (#)	VOY SUR (#)	HEURES BRUTES (HRES)	HEURES RESERVE (HRES)	HEURES PANNES (HRES)	DELAIS MINEURS (HRES)	DISPONIBLE (#)	DISPONIBLE (%)	UTILISATION (#)	UTILISATION (%)
P & H	412.4	22310.	11283.	11027.	0.	519.	286.	233.	0.	54.1	0.1	89.8	3.9	2.3	37.6	2.3	99.8
B.E.	348.2	5641.	5641.	0.	0.	143.	143.	0.	0.	16.2	0.0	55.8	2.5	0.7	22.5	0.7	100.0
MARION	408.1	17448.	10099.	7369.	0.	415.	256.	159.	0.	42.8	0.1	29.1	4.0	1.8	59.6	1.8	99.8
D-600	187.1	3106.	986.	2120.	0.	75.	25.	50.	0.	16.6	0.0	31.4	2.5	0.7	34.6	0.7	100.0
L-700	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

EFFICACITE DES D-600 -JOUR- % 126.

TOTAL (EXCLUANT LES L-700 & D-600)

	401.6	45419.	27023.	18396.	0.	1077.	685.	392.	0.	113.1	0.2	174.7	10.4	4.7	39.3	4.7	99.8

EFFICACITE DES PELLES -JOUR- % 112. HEURES CEDULEES= 24.

CUMULE DU MOIS

P & H	406.0	162303	84778.	77525.	0.	3785.	2149.	1636.	0.	399.8	3.6	1036.6	39.4	1.7	28.0	1.7	99.1
B.E.	417.3	150904	96258.	54646.	0.	3597.	2440.	1157.	0.	361.6	2.6	355.8	33.9	1.5	50.6	1.5	99.3
MARION	400.8	152791	108685	44107.	0.	3693.	2755.	938.	0.	381.2	14.1	324.7	32.2	1.6	54.9	1.6	96.4
D-600	201.6	13771.	8206.	5565.	0.	333.	208.	125.	0.	68.3	1.2	410.5	6.8	0.3	14.5	0.3	98.3
L-700	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

EFFICACITE DES D-600 -MOIS- % 136.

TOTAL (EXCLUANT LES L-700 & D-600)

	407.8	465999.	289721.	176278.	0.	11075.	7344.	3731.	0.	1142.6	20.3	1717.1	105.5	4.8	40.4	4.8	98.3

EFFICACITE DES PELLES -MOIS- % 114. HEURES CEDULEES= 240.

Fig. 28. QCL's Shovel Production Report

CAMIONS

NO.DE CAMION (#)	TYPE	VOYAGES TOTAL (#)	VOLUME TOTAL (M.C)	VITESSE (MC/HR)	HEURES BRUTES HRES)	HEURES RESERVE (HRES)	HEURES PANNES (HRES)	DELAIS MINEURS (HRES)	DISPONIBILITE (#)	DISPONIBILITE (%)	UTILISATION (#)	UTILISATION (%)
701	L-HAUL	29	1344.	115.9	11.6	3.1	9.3	0.6	14.7	61.25	11.6	78.9
702	L-HAUL	2	79.	16.1	4.9	0.2	18.9	0.0	5.1	21.25	4.9	96.0
703	L-HAUL	23	1002.	97.2	10.3	3.7	10.0	1.2	14.0	58.33	10.3	73.5
704	L-HAUL	18	781.	104.1	7.5	16.5	0.0	0.9	24.0	100.0	7.5	31.2
705	L-HAUL	47	1996.	95.5	20.9	2.0	1.1	1.8	22.9	95.42	20.9	91.2
706	L-HAUL	40	1790.	91.8	19.5	4.5	0.0	1.5	24.0	100.0	19.5	81.2
707	L-HAUL	26	1085.	74.3	14.6	4.3	5.1	1.4	18.9	78.75	14.6	77.2
708	L-HAUL	0	0.	0.0	0.0	0.0	24.0	0.0	0.0	0.00	0.0	0.0
712	WABCO	47	1948.	86.6	22.5	1.5	0.0	1.2	24.0	100.0	22.5	93.7
714	WABCO	49	2063.	87.0	23.7	0.3	0.0	2.3	24.0	100.0	23.7	98.7
715	WABCO	7	311.	76.0	4.1	1.3	18.6	1.0	5.4	22.50	4.1	75.9
716	WABCO	25	1163.	109.7	10.6	2.2	11.2	0.4	12.8	53.33	10.6	82.8
717	WABCO	0	0.	0.0	0.0	0.0	24.0	0.0	0.0	0.00	0.0	0.0
718	WABCO	53	2409.	109.0	22.1	1.7	0.2	1.8	23.8	99.17	22.1	92.8
719	WABCO	1	39.	98.6	0.4	1.0	22.6	0.0	1.4	5.83	0.4	28.5
720	WABCO	50	2208.	94.8	23.3	0.7	0.0	2.1	24.0	100.0	23.3	97.0
747	WABCO	32	1439.	102.1	14.1	1.1	8.8	1.8	15.2	63.33	14.1	92.7
748	WABCO	39	1574.	84.2	18.7	5.3	0.0	2.2	24.0	100.0	18.7	77.9
749	WABCO	60	2756.	123.6	22.3	1.7	0.0	1.2	24.0	100.0	22.3	92.9
723	TEREX	49	2001.	91.8	21.8	1.7	0.5	2.7	23.5	97.92	21.8	92.7
725	TEREX	12	485.	115.5	4.2	0.0	19.8	0.0	4.2	17.50	4.2	100.
726	TEREX	51	2068.	91.9	22.5	0.6	0.9	1.4	23.1	96.25	22.5	97.4
727	TEREX	0	0.	0.0	0.0	0.0	24.0	0.0	0.0	0.00	0.0	0.0
728	TEREX	58	2359.	109.7	21.5	1.9	0.6	0.9	23.4	97.50	21.5	91.8
729	TEREX	55	2264.	97.2	23.3	0.7	0.0	2.5	24.0	100.0	23.3	97.0
730	TEREX	21	840.	80.8	10.4	0.0	13.6	1.2	10.4	43.33	10.4	100.
731	TEREX	0	0.	0.0	0.0	0.0	24.0	0.0	0.0	0.00	0.0	0.0
732	TEREX	42	1701.	76.3	22.3	0.5	1.2	2.8	22.8	95.00	22.3	97.8
733	TEREX	45	1831.	95.9	19.1	0.7	4.2	1.8	19.8	82.50	19.1	96.4
734	TEREX	47	1907.	85.1	22.4	1.1	0.5	2.2	23.5	97.92	22.4	95.3
736	TEREX	48	1932.	89.9	21.5	2.5	0.0	2.1	24.0	100.0	21.5	89.5
738	TEREX	48	1979.	95.6	20.7	3.3	0.0	1.8	24.0	100.0	20.7	86.2
739	TEREX	0	0.	0.0	0.0	0.0	24.0	0.0	0.0	0.00	0.0	0.0
740	TEREX	50	2020.	91.0	22.2	1.2	0.6	2.4	23.4	97.50	22.2	94.8
741	TEREX	1	39.	39.5	1.0	0.0	23.0	0.0	1.0	4.17	1.0	100.
742	TEREX	27	1098.	83.2	13.2	3.3	7.5	1.7	16.5	68.75	13.2	80.0
743	TEREX	50	2014.	98.7	20.4	3.6	0.0	2.4	24.0	100.0	20.4	85.0

Fig. 29. QCL's Truck Production Report

PERFORMANCE

	MINE PRINCIPALE	MINE OUEST	TOTAL
VOLUME MINERAI	8324.	7614.	15938.
STERILE	920.	537.	1457.
SURFACE	0.	0.	0.
TOTAL PRODUCTION	9244.	8151.	17395.
NON-PRODUCTION			0.
DE LA PILE			0.
AGREGAT			0.
TOTAL TRANSPORTE			17395.
VOYAGES MINERAI	211.	193.	404.
STERILE	19.	11.	30.
SURFACE	0.	0.	0.
TOTAL PRODUCTION	230.	204.	434.
NON-PRODUCTION			0
DE LA PILE			0
AGREGAT			0
TOTAL TRANSPORTE			434
MOYENNE DE PELLES UTIL.	2.7	2.4	5.1
VOYAGES PAR PELLE	86.0	79.2	82.8
MOYENNE DE PELLES DISP.			5.7
MOYENNE DES CHARGEUSES			0.6
VOYAGES DES CHARGEUSES	13. PAR CHARGEUSES		25.0
MOYENNE DE CAMIONS UTIL.			21.3
VOYAGES PAR CAMION			20.4
MOYENNE DE CAMIONS DISP.			25.2
TENEUR MOYENNE DU MINERAI	....	....	....
TENEUR MOYENNE DU MINERAI CONC.			.....

	LIGNE 1	LIGNE 2	TOTAL
CONCASSEUR HORS D'USAGE	0.2	0.0	0.2
ATTENTE AU CONCASSEUR (MIN)			146
TONNAGE BROYE			.....
TONNAGE CONCENTRE			.....
MOYENNES DES FOREUSES			.....
METRES FORES			.....
MOYENNE PAR FOREUSE			.....
TONNAGE RECYCLE CONC.			.....

HAUTEUR DES SILOS

1	2	3	4	5	6

ATTENTE DES PELLES 6.5 HRES.
ATTENTE DES CAMIONS 14.4 HRES.

.... INDIQUER LE NOMBRE DE VOY. DE NEIGE
.... INDIQUER LE NOMBRE DE VOY. EN AVANT DU C

EQUIPEMENT	DEBUT	FIN	#OPER	H.O.	RESER
PELLES			40.5	4.7	
CHARGEUSES			4.8	0.0	
CAMIONS			170.5	31.0	
FOREUSES					
TRACTEUR 824					
TRACTEUR D-9					
NIVELEUSES					
CAMIONNETTES					

TENEUR DU CONCENTRATEUR

22:30 00:30	02:30	04:30
-1- -2-	-3-	-4-

REMARQUES:

Fig. 30. QCL's Mine Production Report